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Costs of Operation and Maintenance Activities (Army): Techniques for Analysis and Estimation

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FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

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FOREWORD

This report is part of a continuing research effort of the Economics and Costing Department of RAC aimed at developing and improving costing methods applicable to Army resource problems, primarily in the planning area of Army management. This research was sponsored by the Office of the Comptroller of the Army.

The research reported in this paper develops a method for determining the cost impact of proposed force changes on the operation and maintenance, Army (OMA) appropriation activities. A study of the Army's financial accounting system structure and budget data has been made to form a method that will determine those OMA activities that depend on force changes. For these activities illustrative cost-estimating relations (CERs) are developed.

Further research on cost-generating activities is planned.

Arnold Proschan
Head, Economics and Costing Department

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SUMMARY

Problem

To formulate methods and techniques that will (a) identify and classify the operation and maintenance, Army (OMA) activities that are force-dependent with changes in the Army's force structure, and (b) determine the cost of the designated force-dependent OMA activities for incremental force-planning purposes.

Facts

Planning decisions by military management today require the estimation of the total incremental cost of each proposed force change alternative under consideration. A force change can be a change in the table(s) of organization and equipment (TOE) mix, additional TOEs, reorganization of a TOE, or a new TOE with a new materiel item or weapon system. The total incremental cost of a proposed force change may include costs from five appropriations for the active Army: procurement of equipment and missiles, Army (PEMA); military personnel, Army (MPA); Military Construction, Army (MCA); research, development, test and evaluation, Army (RDTE); and OMA. This paper is concerned only with the techniques for analysis of the OMA appropriation for use in force-change related costing.

The OMA appropriation in the main represents the annual recurring costs of operating and maintaining a force; hence it is of direct interest to the planner. To meet the planner's need, an effective system is required to determine the incremental OMA costs of each alternative force change.

Discussion

Past Methods

Military cost analysts have found OMA costs difficult to treat in the context of incremental force costing. Previous solutions were only stop-gap responses to particular incremental force-costing needs. These responses reflected the lack of a general OMA methodology.

There have been three specific problems: First, through assuming that the total OMA cost depends only on the number of personnel in the force, the analysis of the functional relations that generate OMA costs has usually been ignored.

Second, treating force-change costs as extrapolations of the average total cost of an existing similar force typically overstates costs because costs that do not depend on a force change are included.

Third, a cost analysis error frequently committed but not unique to incremental force-costing problems is the implicit amortization of sunk costs by inclusion of inherited existing assets. These costs do not apply to the variable costs that are the main subject of this paper.

Outline of a New Method

The research reported in this paper develops a method for determining the cost impact of force changes on the OMA appropriation. The method is built around the Army's financial accounting system and relies primarily on Army budget data. To determine the OMA cost impact of a force change, several classifications are made using the accounts of the financial accounting code.

Each account is identified to a level of detail for which there are both OMA cost descriptions and activity measures (physical or dollar). These accounting activities are then classified as to how they will be affected by a force change and how this in turn will result in an incremental OMA cost. The classifications are (a) fixed and hence not dependent on force changes, (b) dependent on changes in military personnel, (c) dependent on changes in military materiel, or (d) dependent on changes in both military personnel and materiel. A final classification determines for each of the three types of force-dependent activities whether the activity is annual operating OMA or initial investment OMA.

Classification of OMA activities as to type of force dependency enables the computation of coefficients that relate specific accounting activity costs to physical measures that depend on force changes. For each account, relations are derived that convert a physical measure determined by a force change into the accounting activity cost. This is done either by the use of aggregate costs and measures or by linear regression analysis of costs and measures.

The cost-estimating relations (CERs) developed in this study are illustrative examples of the use of this new method. A complete set of illustrative force-planning OMA factors and CERs has been developed except for the cost of training military occupation specialties (MOSs). Training costs are being developed in another RAC study and are therefore excluded from this one. The applicability of these factors and CERs can only be determined in the context of a particular cost study. They are not meant to be applied routinely to any and all cost problems.

Conclusions

1. The cost of OMA activities for incremental force costing can be determined using the methods described in this paper.
2. The method is applicable to force-structure cost analyses and force-level cost-effectiveness studies.
3. With a more detailed data base such as could be developed from logistics and support systems, the method can be extended to weapon-systems-level cost analyses.

Costs of Operation and Maintenance Activities (Army): Techniques for Analysis and Estimation

ABBREVIATIONS

AMC	Army Materiel Command
AMP	Army Materiel Plan
AMS	army management structure
AR	Army Reserve
ARADCOM	United States Army Air Defense Command
BOQ	bachelor officer's quarters
BL	bill of lading
BP	budget program
BPA	budget project account
CA	cost account
CER	cost-estimating relation
COB	Command Operating Budget
CONUS	continental United States
DA	Department of the Army
DOD	Department of Defense
FYFSFP	Five-Year Force Structure and Financial Program
MCA	Military Construction, Army (appropriation)
MOS	military occupational specialty
MPA	military personnel, Army (appropriation)
NG	National Guard
OJT	on-the-job training
OMA	operation and maintenance, Army (appropriation)
OMF	operation and maintenance of facilities (budget program)
PCS	permanent change of station
PEMA	procurement of equipment and missiles, Army (appropriation)
POL	petroleum, oils, and lubricants
RDTE	research, development, test and evaluation (appropriation)
ROTC	Reserve Officer's Training Corps
SCA	summary cost account
SRC	standard requirement code
STEP	Special Training and Enlistment Program
TAERS	The Army Equipment Records System
TOA	Total Obligational Authority
TOE	table(s) of organization and equipment
STRICOM	Strike Command

Chapter 1

INTRODUCTION

PURPOSE

The research reported in this paper is specifically limited to the OMA appropriation and is concerned only with those costs in the appropriation that are relevant to that aspect of the military force-planning process dealing with changes in the combat, combat support forces, and combat service support. Throughout this paper these planning issues are referred to either as force changes or incremental forces. As used in this paper a proposed force structure change can include (a) addition of current TOE units, (b) deletion of TOE units, (c) reorganization of a current TOE unit, (d) rearrangement of the number and type of TOE units in a geographical theater, or (e) addition of new TOE units.

The research is directed toward the development of a method for identifying those OMA activities that depend on proposed force changes. For each of the force-dependent activities identified, the functional relations of the activity to personnel or materiel changes are determined. The activity cost is then determined with respect to these changes.

The CERs that are developed in this paper are highly aggregated and are tailored specifically to force-change costs for decisions. The CERs are readily applicable to significant force changes, i.e., brigade-sized force with necessary support, or involving at least 10,000 men. Although the costing of smaller force changes requires attention to possible variance in the CERs related to a greater level of detail or specificity, the method and most of the CERs are applicable. CERs will not, nor were they intended to, determine cost differences for cost-effectiveness studies of alternative materiel items or for estimating OMA logistic procurement recurring costs.

The remainder of this chapter outlines some limitations of this study. Chapter 2 discusses the development and application of the method in general terms. Chapter 3 presents the detailed development of illustrative CERs that are applicable in determining the OMA cost of an incremental force.

LIMITATIONS OF THE STUDY

The research undertaken in this paper is an exploratory development of a method for using the Army's accounting data to estimate the OMA costs of

an incremental force. Although the method does provide a quick and fairly simple technique for estimating the OMA costs of an incremental force, more data than are provided in this paper are required for the full use of the method. Sensitivity analysis indicates that the following three topics and activities require additional research.

Operating Forces, Budget Program 2000

This budget program contains the largest dollar-cost activities of an incremental force, as aggregated activities in single accounts that must be disaggregated before OMA cost analysis can be undertaken. More research is necessary to determine these aggregated activities and the fraction of total account costs because of their great impact on OMA costs.

Relation of Incremental Forces to Activities

The functional relations used in this paper for relating activities to incremental forces need further investigation. Those activities that are materiel dependent require much more detailed analysis. The assumptions used to determine quantities of an activity to be related to an incremental force require testing. Testing these assumptions requires data that can be obtained only from a study at selected locations of current forces, facilities, and activities.

Other

The analysis could be extended to include costs for each geographical command area, e.g., continental United States (CONUS), Europe, or Pacific. A related study could be the development of a method and costing techniques for evaluating non-force-related cost of alternative facility locations, the cost of alternative field headquarters, and the cost of alternative locations of logistics activities. This would expand the cost analysis into the institutional-support area.

Chapter 2

METHOD FOR THE DETERMINATION OF FORCE-DEPENDENT OMA ACTIVITIES AND THEIR COSTS

This chapter develops a method for determining the specific OMA activities that depend on force changes, relates these activities to a force change, and establishes methods for determining the incremental OMA costs of force changes for use in cost analysis for Army planning. The chapter is subdivided into three topics, each a major aspect of the determination of force-dependent OMA activities and their cost: (a) classification of accounting activities according to type of force dependency and OMA cost, (b) cost-estimating methods for relating costs to an incremental force, and (c) data requirements and sources for determining incremental OMA costs and activity measurement.

THE CLASSIFICATION PROCESS

To determine the incremental cost of force changes the Army's financial accounting system as described in AR 37-100,[1] the army management structure (AMS) is used as a structural framework for analysis. Retaining the AMS has two advantages: (a) Army cost analysts are familiar with the AMS, and (b) account dollars can be used as control totals for a check on completeness of the estimating techniques and for performing sensitivity analysis.

The classification process begins by determining which AMS accounting activities and their fiscal codes are to be classified as fixed and not dependent on changes in combat or combat support forces. The accounting activities that are determined to be force-dependent are further classified as to type of force dependence, viz, materiel, materiel and personnel, or personnel. A third classification determines whether the accounting activity represents an annual operating cost and/or an initial investment cost with respect to a force change. The classification process is shown as a tree diagram in Fig. 1.

The actual classification process is relatively easy to do and can be changed in response to changes in accounts and activities. The classification process is necessarily subjective, using only knowledge and past Army experience as guidance. Therefore it is imperative that the process permit ease of changing as more knowledge and experience are gained about the dependency of an account or activity.

In the classification process nine types of institutional activities were found to be independent of combat and combat support force changes and hence were designated as fixed. These activities are: (a) CONUS departmental

headquarters; (b) administrative or joint activities when the Army is designated the administrative agency; (c) research and development activities; (d) Reserve and National Guard (NG) activities; (e) civil defense, raw material stockpiling, and Reserve industrial activities; (f) operation and maintenance of facilities (OMF) of fixed CONUS service and/or logistical activities; (g) Armywide information and communication activities; (h) US Military Academy; and (i) inactive facilities.

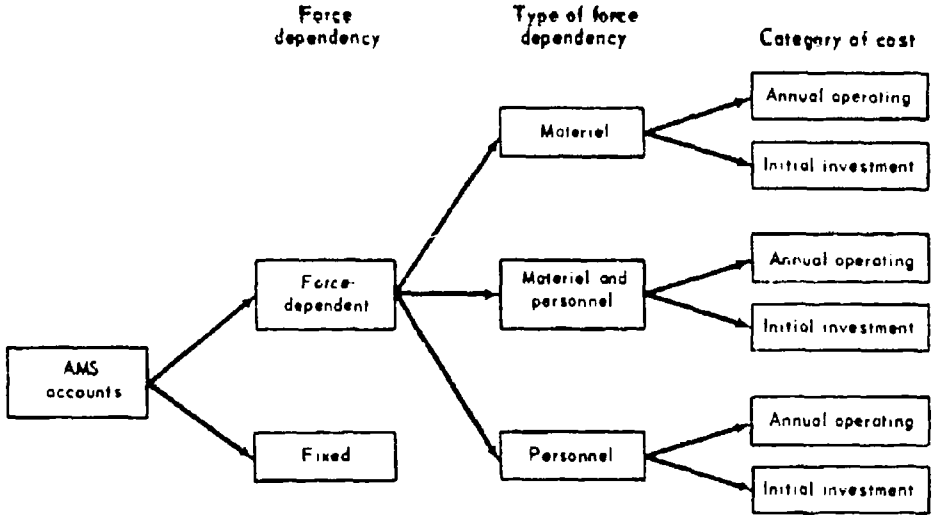


Fig. 1—The Classification Process

The AMS Fiscal Codes

Since the classification process uses the AMS as a framework, the AMS requires description for those not familiar with it. The AMS contains the fiscal codes and activity descriptions of all the appropriations used by the Army. The OMA appropriation is separated into eight (BP 2600 and BP 2700 are not used) budget programs (BPs), also called "activities," as shown in the accompanying tabulation.

Code	Program
2000.0000	Operating Forces
2100.0000	Training Activities
2200.0000	Central Supply Activities
2300.0000	Major Overhaul and Maintenance of Materiel
2400.0000	Medical Activities
2500.0000	Army-Wide Activities
2800.0000	Intelligence Activities
2900.0000	Army-Wide Communications and Pictorial Services

Each of these budget programs is further subdivided into budget project accounts (BPAs), e.g., 2020.0000. Additional subdivision of the BPAs is accomplished by use of the codes to the right of the decimal point, e.g., 2020.1, 2020.11, 2020.111, 2020.1111. The nomenclature of this structure is summarized in the accompanying tabulation.

Code	Program
2X00.	Budget Program (Activity) (BP)
2XXX.	Budget Project Accounts (BPA)
2XXX.X	Summary Cost Account (SCA)
2XXX.XX	Cost Account (CA)
2XXX.XXX	Cost Account (CA)
2XXX.XXXX	Cost Account (CA)

The budget programs for OMA are functional groupings of similar activities, e.g., Central Supply Activities (BP 2200), and Army-Wide Activities (BP 2500) and/or broad mission activity groupings, such as Training (BP 2100), and Medical Activities (BP 2400). The assignment and definition of subactivities of a budget program are quite flexible; changes and reassignments occur frequently. The reassignment of subactivities is, indeed, one of the major problems in the construction of aggregate account OMA time series. Therefore achieving and maintaining an understanding of the OMA institutional structure is a primary prerequisite for an OMA analysis.

Restructuring the AMS Accounts

The classification shown in Table 1 is restructured in Table 2 by type of independent variable. These are materiel dependent, materiel and personnel dependent, and personnel dependent. Since the OMA activities that are fixed are no longer of interest, these activities are not included in Table 2.

Within the above classification the AMS accounting activities are next grouped into homogeneous force-dependent categories having the same independent variable(s). The reason for introducing this activity structure is that in estimating the cost of a force change it is the force-dependent activity that is to be estimated and not the AMS accounting activity. In addition, aggregation is made in Table 2 either because the disaggregation of the AMS is not required or because of lack of detailed data. This category structure is as follows:

Materiel-Related OMA
- Maintenance
- Petroleum, oils, and lubricants (POL)

Materiel- and Personnel-Related OMA
- General Supplies
- OMA materiel
- Training
- Stock, Store, and Issue Activities

Personnel-Related OMA
- Armywide Services
- Command and Direction

TABLE I

Cost Dependency of Activities on Force Changes[1]

Activities	AMS codes	Fixed	Personnel related		Materiel related		FY66 budget,[2] thous of dollars
			Annual operating	Initial investment	Annual operating	Initial investment	
Operating Forces BP 2000	2000	—	—	—	—	—	(1,755,100)
Operation and Maintenance of Facilities	2009	—	—	—	—	—	611,070
Operating Forces (except ARADCOM)	2009.1	x	x	—	x		
ARADCOM only	2009.2	x	x	—	x		
Operating Forces (less ARADCOM)	2020	—	x	x	x	x	901,070
U.S. Army Air Defense Command (ARADCOM)	2030	—	x	x	x	x	22,841
Field Exercises	2040	x	—	—	—	—	72,782
Special Tactical Activities	2050	x	—	—	—	—	47,340
Training Activities BP 2100	2100	—	—	—	—	—	(316,700)
Operation and Maintenance of Facilities	2109	x	x	—	—	—	168,060
Operation of Schools	2110	—	—	—	—	—	99,550
Military, Technical and Other Training	2110.1						
Combat Arms Schools and Misc. CONARC	2110.11	—	x	x	x	x	
CONARC Tech. Training Activities (except Medical)	2110.12	—	x	x	x	x	
CONARC Administrative Service Schools	2110.13	—	x	x			
AMC Training Activities (except Medical)	2110.14	x					
Other Training Activities	2110.15	x					
Defense Language Institute	2110.16	x					
Flying Training	2110.2	—	x	x	x	x	
Student Temporary Dut. Travel and Per Diem	2110.3	—	x	x			
U.S. Military Academy	2120	x	—	—	—	—	7,500
Other School Training	2130	x	—	—	—	—	6,126
Training Devices and Publications	2140	x	—	—	—	—	11,625
Replacement Training in U.S. Army Training Centers (less AR and NG)	2150	—	x	x	—	—	23,472
Central Supply Activities BP 2200	2200	—	—	—	—	—	(859,900)
Operation and Maintenance of Facilities	2209	—	—	—	—	—	(180,328)
Except Property Disposal	2209.1	x	—	—	—	—	180,328
Property Disposal only	2209.2	x	—	—	—	—	0

Procurement Operations	2210	—	—	—	—	—	(150,449)
Central Procurement Activities	2210.1	—	×	×	×	×	103,690
Standardization	2210.3	×	—	—	—	—	15,500
Industrial Preparedness Planning	2210.4	×	—	—	—	—	12,396
Real Estate Administration	2210.5	×	—	—	—	—	5,142
Facilities Mobilization Planning	2210.6	×	—	—	—	—	62
Facilities Investigation and Studies	2210.7	×	—	—	—	—	1,770
Applications Engineering	2210.8	×	—	—	—	—	6,884
Operation of Supply Depots	2220	—	—	—	—	—	(109,479)
Supply Depot Operations	2220.1	—	—	—	—	—	93,616
Depot Receiving Activity	2220.11	—	×	×	×	×	
Care and Preservation—Cyclical	2220.12	×					
Care and Preservation—Processing in Storage	2220.13	×					
Other Depot Storage Activity	2220.14	—	×	×	×	×	
Depot Issue Activity	2220.15	—	×	×	×	×	
Unit and Set Assembly and Disassembly	2220.17	×					
Depot Operations—Direct Overhead	2220.18	—	×	×	×	×	
Logistical Services	2220.2	×	—	—	—	—	15,863
Supply Management Operations	2230	—	—	—	—	—	(81,974)
Inventory Management Activities	2230.1	—	—	—	—	—	68,944
Integrated Materiel Inventory Management Operations—Major Items	2230.11	×					
Integrated Materiel Inventory Management Operations—Minor Items	2230.12	×					
Stock Control Operations	2230.13	—	×	—	×		
Logistical Services	2230.14	×					
Mutual Security Program Control	2230.15	×					
Cataloging (except Medical)	2230.2	×	—	—	—	—	16,030
Reserve Industrial Facilities	2240	×	—	—	—	—	31,350
Transportation Services	2250	—	—	—	—	—	(209,768)
Land Transportation, Commercial Line-Haul	2250.1	—	×	×	×	×	48,071
Air Transportation	2250.2	×	—	—	—	—	46,715
Sea Transportation	2250.3	—	—	—	—	—	108,725
Dry Cargo	2250.31	—	×	×	×	×	
Bulk POL	2250.32	×					
Passengers	2250.33	×					
Forward Floating Depots	2250.34	×					
Floating Aircraft Maintenance Facilities	2250.35	×					
Contractual Rental and Lease	2250.4	×	—	—	—	—	3,025

TABLE 1 (continued)

Activities	AMS codes	Fixed	Personnel related		Material related		FY56 budget,[a] thous of dollars
			Annual operating	Initial investment	Annual operating	Initial investment	
Through BL Movements	2350.5	•	—	—	—	—	1,727
Transportation of TOE Equipment	2350.6	—	—	—	—	•	1,705
Operation of Port Terminals and Facilities	2370	—	—	—	—	—	(49,987)
Operation of Ports and Terminals	2370.1	—	—	—	—	—	68,435
Cargo	2370.11	—	•	•	•	•	
Passengers	2370.12	•					
Operation of Watercraft	2370.13	•					
Special Missions	2370.14	•					
Transportation Engineering	2370.2	•	—	—	—	—	595
Operation of Other Transportation Facilities	2370.3	•	—	—	—	—	957
Logistics Control and Direction	2380	•	—	—	—	—	34,351
Major Overhaul and Maintenance of Materiel BP 2300	2300	—	—	—	—	—	(274,500)
Operation and Maintenance of Facilities	2309	•	—	—	—	—	7,863
Major Overhaul Activities	2310	—	—	—	—	—	(21,469)
Weapons	2310.1	—	—	—	•	—	6,401
Combat Vehicles	2310.2	—	—	—	•	—	39,134
Tactical and Support Vehicles	2310.3	—	—	—	•	—	10,042
Electronic and Comm. Equipment	2310.4	—	—	—	•	—	12,922
Aircraft	2310.5	—	—	—	•	—	15,716
Missile Systems	2310.6	—	—	—	•	—	3,089
All Other Equipment	2310.7	—	—	—	•	—	7,564
Modification Activities	2330	•	—	—	—	—	8,103
Renovation of Ammunition and Special Weapons Activities	2330	•	—	—	—	—	5,937
Maintenance Assistance and Engineering Services	2340	•	—	—	—	—	87,856
Related Maintenance Activities	2350	—	—	—	—	—	(31,118)
Repair and Serviceability Testing (less Aircraft 2350.151)	2350.1	—	—	—	•	—	11,579
Fabrication	2350.2	—	—	—	•	—	937
Other Related Maintenance Activities	2350.4	—	—	—	•	—	8,845
Aircraft	2350.15	—	—	—	•	—	9,756

Procurement of Basic Issue List Items, Modification Kits, and Capital Equipment	2360	—	—	—	—	—	[illegible]
Basic Issue List Items	2360.5	—	—	—	—	—	3,[illegible]5
Modification Kits	2360.6	x	—	—	x	—	[illegible],254
Capital Equipment	2360.7	x	—	—	—	—	[illegible],027
Medical Activities BP 2400	2400	—	—	—	—	—	[illegible],[illegible]0
Operation and Maintenance of Facilities	2409	x	—	—	—	—	9,[illegible]8
Office of The Surgeon General	2410	x	—	—	—	—	3,181
Operation of Hospitals, Dispensaries, and Dental Service Units	2420	—	x	—	—	—	91,963
Medical Services in Non-Army Facilities, except Medicare Administered by Executive Agent (less Physical Examination of Army Reserve and National Guard Personnel from 2430.9)	2430	—	x	—	—	—	23,747
Medicare Administered by Executive Agent (less Office of Dependent Medical Care (ODMC) Office Costs from 2440.1)	2440	—	x	—	—	—	22,77[illegible]
Medical Training	2450	x	—	—	—	—	6,142
Other Medical Activities	2460	x	—	—	—	—	17,105
Army-Wide Activities BP 2500	2500	—	—	—	—	—	383,357
Operation and Maintenance of Facilities	2509	x	—	—	—	—	44,10[illegible]
Department Headquarters	2510	x	—	—	—	—	60,600
Major Field Command Headquarters	2520	—	—	—	—	—	[illegible]71,732
Personnel Compensation and Benefits	2520.1	—	x	—	—	—	63,693
Travel and Transportation of Personnel	2520.2	—	x	—	—	—	2,821
Supplies, Materials, and Equipment	2520.3	—	x	—	—	—	2,192
Other Costs	2520.4	—	x	—	—	—	3,026
Recruiting and Other Personnel Support	2530	—	x	x	—	—	22,05[illegible]
Other Administrative Services (less Reserve and National Guard Maintenance of Personnel Records)	2540	—	x	—	—	—	84,909
Army-Wide Finance and Audit Services	2580	—	x	—	—	—	48,729
Joint Projects	2590	x	—	—	—	—	8,131
Employees Compensation (applies to above BP 2500 Accounts)	—	—	—	—	—	—	3,092
Intelligence Activities BP 2800	2800	x	—	—	—	—	[illegible]22,675
Army-Wide Communication and Pictorial Services BP 2900	2900	x	—	—	—	—	141,468

TABLE 1 (continued)

Activities	AMS codes	Fixed	Personnel related		Materiel related		FY66 budget,[a] thous of dollars
			Annual operating	Initial investment	Annual operating	Initial investment	
Operation and Maintenance of Facilities BP 9000[b]	9000			—			
Local Headquarters Command Administration	9010	—	—	—	—	—	(87,474)
Headquarters Operations	9010.1	—	×	—	—	—	70,817
Preservation of Order	9010.2	—	×	—	—	—	8,108
General Educational Development of Military Personnel	9010.3	—	×	—	—	—	7,752
BOQ and Civilian Dormitory Furniture	9010.4	—	×	—	—	—	797
Local Welfare Services	9020	×	—	—	—	—	12,258
Local Maintenance and Management of Facilities	9030	—	—	—	—	—	(255,331)
Maintenance of Active Facilities	9030.1	—	×	—	—	—	238,370
Inactive Facilities	9030.2	×	—	—	—	—	2,040
Special Activities	9030.3	×	—	—	—	—	2,472
DA Sponsored Projects	9030.4	×	—	—	—	—	0
Rents, Initial Alterations and Restorations	9030.5	×	—	—	—	—	10,947
Land Payments and Deficiency Judgments	9030.6	×	—	—	—	—	0
Master Planning	9030.7	×	—	—	—	—	1,502
Field Maintenance	9040	—	—	—	—	—	(120,725)
Weapons	9040.1	—	—	—	×	—	3,385
Combat Vehicles	9040.2	—	—	—	×	—	6,252
Tactical and Support Vehicles	9040.3	—	—	—	×	—	30,210
Electronic and Communication Equipment	9040.4	—	—	—	×	—	9,057
Aircraft	9040.5	—	—	—	×	—	8,199
Missile Systems	9040.6	—	—	—	×	—	30,852
All Other Equipment	9040.7	—	—	—	×	—	32,770
Local Logistics Services	9050	—	—	—	—	—	(136,399)
Post Supply	9050.1	—	×	—	×	—	47,532
Communication and Photographic Services	9050.2	×	—	—	—	—	20,810
Transportation Services	9050.3	×	—	—	—	—	35,076
The Army Food Program	9050.4	—	×	—	—	—	24,711
Laundry and Drycleaning Services	9050.5	—	×	—	—	—	8,270
Purchased OMF	9060	×	—	—	—	—	6,584

[a]Numbers in parentheses are totals of following subcategories.
[b]Includes specific activities for operation and maintenance of facilities in BP 2000.

TABLE 2

Force-Dependent OMA Activities

(Extracted from Table 1)

OMA activity	Code		Annual operating	Initial investment
	Mission 2XXX	OMF 90XX		
Materiel Related				
Maintenance				
Support Maintenance (Direct and General)	2000	—	—	—
OMF	2009	9040	—	—
Weapons	—	9040.1	x	x
Combat Vehicles	—	9040.2	x	x
Tactical and Support Vehicles	—	9040.3	x	x
Electronic and Communication Equipment	—	9040.4	x	x
Aircraft	—	9040.5	x	x
Missile Systems	—	9040.6	x	x
All Other Equipment	—	9040.7	x	x
Operating Forces (less ARADCOM)	2020	—	x	x
US Army Air Defense Command (ARADCOM)	2030	—	x	x
Aircraft (General Support)	2350.15	—	x	—
Depot Maintenance	2300	—	—	—
Major Overhaul Activities	2310	—	—	—
Weapons	2310.1	—	x	—
Combat Vehicles	2310.2	—	x	—
Tactical and Support Vehicles	2310.3	—	x	—
Electronic and Communication Equipment	2310.4	—	x	—
Aircraft	2310.5	—	x	—
Missile Systems	2310.6	—	x	—
All Other Equipment	2310.7	—	x	—
Related Maintenance Activities	2350	—	—	—
Repair and Serviceability Testing	2350.1	—	x	—
Fabrication	2350.2	—	x	—
Other Related Maintenance Activities	2350.4	—	x	—
Basic Issue List Items	2350.5	—	x	—
POL				
Operating Forces (less ARADCOM)	2020	—	x	—
US Army Air Defense Command (ARADCOM)	2030	—	x	—
Materiel and Personnel Related				
General Supplies				
Operating Forces (less ARADCOM)	2020	—	x	—
US Army Air Defense Command (ARADCOM)	2030	—	x	—
OMA Materiel				
Operating Forces (less AHADCOM)	2020	—	x	x
US Army Air Defense Command (ARADCOM)	2020	—	x	x
Training				
Operation and Maintenance of Facilities	2109	—	—	—
Training Activities	2109.1	—	x	—
Operation of Schools	2110	—	—	—
Military, Technical and Other Training	2110.1	—	—	—
Combat Arms Schools and Misc. CONARC	2110.11	—	x	x

TABLE 2 (continued)

OMA activity	Code		Annual operating	Initial investment
	Mission 2XXX	OMF 90XX		
CONARC Technical Training Activities (except Medical)	2110.12	—	×	×
CONARC Administrative Service Schools	2110.13	—	×	×
Flying Training	2110.2	—	×	×
Student Temporary Duty Travel and Per Diem	2110.3	—	×	×
Stock, Store and Issue Activities				
Central Procurement Activities Operation and Maintenance of Facilities (except Property Disposal)	2210.1	—	×	×
Supply Depot Operations	2220.1	—	—	—
Depot Receiving Activity	2220.11	—	×	×
Other Depot Storage Activity	2220.14	—	×	×
Depot Issue Activity	2220.15	—	×	×
Depot Operations—Direct Overhead	2220.18	—	×	×
Stock Control Operations	2230.13	—	×	—
Transportation Services	2250	—	—	—
Land Transportation, Commercial Line-Haul	2250.1	—	×	×
Sea Transportation	2250.3	—	×	×
Dry Cargo	2250.31	—	×	×
Transportation of TOE Equipment	2250.6	—	—	×
Operation of Ports and Terminals	2270.1	—	—	—
Cargo	2270.11	—	×	×
Post Supply	2009	9050.1	—	—
Operating Forces (except ARADCOM)	2009.1	—	×	—
ARADCOM only	2009.2	—	×	—
Personnel Related				
Army-Wide Services				
Medical Activities	2400	—	—	—
Operation of Hospitals, Dispensaries, and Dental Service Units	2420	—	×	—
Medical Services in Non-Army Facilities, except Medicare Administered by Executive Agent	2430	—	×	—
Medicare Administered by Executive Agent (less Office of Dependent Medical Care (ODMC) Office Costs from 2440.1)	2440	—	×	—
Maintenance of Active Facilities	2009	9030.1	—	—
Operating Forces (except ARADCOM)	2009.1	—	×	—
ARADCOM only	2009.2	—	×	—
The Army Food Program	2009	9050.4 (9050.41–9050.45)	—	—
Operating Forces (except ARADCOM)	2009.1	—	×	—
ARADCOM only	2009.2	—	×	—

TABLE 2 (continued)

OMA activity	Code		Annual operating	Initial investment
	Mission 2XXX	OMF 90XX		
Laundry and Drycleaning Services	2009	9050.5	—	—
Operating Forces (except ARADCOM)	2009.1	—	×	—
ARADCOM only	2009.2	—	×	—
Recruiting and Other Personnel Support	2530	—	×	×
Replacement Training in US Army Training Centers	2150	—	×	×
Other Administrative Services (less Reserve and National Guard Maintenance of Personnel Records)	2540	—	×	—
Army-Wide Finance and Audit Services	2580	—	×	—
Command and Direction				
Local Headquarters Command Administration	2009	9010	—	—
Headquarters Operations	—	9010.1	×	—
Preservation of Order	—	9010.2	×	—
General Educational Development of Military Personnel	—	9010.3	×	—
BOQ and Civilian Dormit ry Furniture	—	9010.4	×	—
Major Field Command Headquarters	2520	—	—	—
Personnel Compensation and Benefits	2520.1	—	×	—
Travel and Transportation of Personnel	2520.2	—	×	—
Supplies, Materials and Equipment	2520.3	—	×	—
Other Costs	2520.4	—	×	—
Travel				
Operating Forces (less ARADCOM)	2020		×	
US Army Air Defense Command (ARADCOM)	2030	—	×	—

Each of these categories is further explained as follows:

(a) Maintenance includes organizational, direct support, general-support and depot-maintenance repair parts, and civilian labor for all materiel items of an incremental force.

(b) POL is the petroleum, oils, and lubricants necessary for operating the materiel items of an incremental force.

(c) General Supplies are all other consumables of an incremental force excluding maintenance repair parts and POL.

(d) OMA materiel is nonexpendable materiel procured and replaced by OMA funds for the incremental force.

(e) Training is the initial and replacement training required to organize and to keep the force as a continuing operational entity. The type of training depends on the major mission items of materiel of the force.

(f) Stock, Store, and Issue Activities are the procurement, supply depot, and transportation activities required in support of the incremental force.

(g) Armywide services are those activities of the garrison, the command, and the Department of the Army (DA) required in the support of military personnel of an incremental force. These activities are in direct support of the force but do not include the combat support and general support organizations that are required in support of combat forces.

(h) Command and Direction is the operation of headquarters for the control and direction of the incremental force.

In restructuring the AMS accounts, due consideration has to be given to certain aspects of the classification analysis: (a) the identification of multiple AMS accounts relating to a single force-dependent specific activity, (b) the identification of multiple force-dependent activities relating to a single AMS account, and (c) the distinction between annual operating OMA and initial-investment OMA.

The first two items are inherent in any analysis that relates a financial accounting system to an end product of activity such as a force element. The multiple-account problem can be easily solved by aggregation of all similar activities of the multiple account into a single force-dependent activity. The disaggregation of force-dependent activities from an aggregate AMS account can prove more difficult, as the identification of each force-dependent activity in the aggregate account must be established. Once the force-dependency of an activity in an aggregated account is established, an additional problem arises with respect to the acquisition of data for the activity. For some activities additional data and analysis are required to relate the activity to the force change.

Classification Analysis

The classification of the AMS is a basic part of the method proposed in this paper. The numerical value of the total OMA cost will depend directly on changes in the classification. A more detailed reclassification of the AMS will require more supporting data than the aggregated budget data used in this paper. Major DA command data, both financial and work measurement, are required to make these analyses. These analyses are outside the scope of this paper.

With the above-described data, it would be desirable to test the total OMA force-dependent cost with respect to the classification, such as definitely fixed, probably fixed, definitely force-dependent, or probably force-dependent. Against this four-way reclassification the independent variables of materiel and personnel could be tested similarly, e.g., definitely materiel-related, probably materiel-related, definitely personnel-related, probably personnel-related. Using the same data a classification analysis could be made for each of the Army's major geographical commands.

An additional test of the classification is the degree or extent to which an account is force dependent, as measured by the proportion of dollars of the account that are force dependent compared with those that are fixed. If the proportion of force-dependent dollars is large, the account is strongly force dependent and sensitive to force changes.

However, the force dependency of an account depends on whether the corresponding activity is operating at full capacity. If it is not, a force change could increase the level of the activity without much change in the corresponding dollars. For Maintenance Repair Parts and POL, the full-employment assumption is valid; however, in Headquarters Operations and other similar activities the full-employment threshold level is much more difficult to ascertain.

Budget accounting data cannot resolve the extent of employment of an activity. In this paper some external ancillary data sources were introduced to determine the level of employment of an account; however, most of the determination had to be done by judgment. There are no tests of these assumptions, and it is doubtful that even the capacities can be determined or measured exactly.

Sensitivity Analysis

One type of sensitivity analysis is to rank the OMA budget programs according to the amount of force-dependent dollars in the programs, from the largest to the smallest. Because the OMA total force-dependent cost is more sensitive to budget programs higher on the ranking list, the degree of correctness of the estimate of small amounts can be ignored, and attention can be concentrated on the activities that generate large dollar amounts.

These rankings are shown in Tables 3 to 7. In these tables, BP 2000 Operating Forces is seen to be the largest program and also the largest contributor to both the materiel- and personnel-dependent classifications. Hence

TABLE 3

Classification Sensitivity Analysis: Total OMA Compared with Force-Dependent OMA, by Budget Program

Budget program	Millions of dollars		Percent force-dependent
	Total	Force-dependent	
OMA	3379.1	1545.0	45.7
BP 2000 Operating Forces	1155.1	817.0	70.7
BP 2100 Training Activities	316.7	120.0	37.9
BP 2200 Central Supply Activities	850.9	271.0	31.8
BP 2300 Major Overhaul and Maintenance of Materiel	274.5	157.0	57.2
BP 2400 Medical Activities	174.3	137.0	78.6
BP 2500 Army-Wide Activities	607.6	43.0	7.1

BP 2000 is the most sensitive account with respect to a force change. In an attempt to reduce uncertainty and to improve the estimate, BPA 2020 and BPA 2030 of BP 2000 were disaggregated and their control totals estimated; however, it became evident that the activities contained in BP 2000 and their costs are prime candidates for future research. The disaggregated activities and their estimated control totals are shown in Table 8.

Each activity that has been classified as force dependent is ranked by dollar amount in Table 9. For those activities that are personnel dependent the cost per incremental military man is also shown in this table. The activities that are materiel dependent are ranked only by dollar amount.

TABLE 4

Classification Sensitivity Analysis: Budget Program Force-Dependent OMA Ranked by Dollar Magnitude

Budget program	Force-dependent, millions of dollars	Percent of total force-dependent
OMA	1545.0	100.0
BP 2000 Operating Forces	817.0	52.9
BP 2200 Central Supply Activities	271.0	17.4
BP 2300 Major Overhaul and Maintenance of Materiel	157.0	10.2
BP 2400 Medical Activities	137.0	8.9
BP 2100 Training Activities	120.0	7.8
BP 2500 Army-Wide Activities	43.0	2.8

TABLE 5

Classification Sensitivity Analysis: Force-Dependent OMA, by Type of Dependency

Budget program	Total force-dependent, millions of dollars	Materiel-dependent, millions of dollars	Percent materiel-dependent	Personnel-dependent, millions of dollars	Percent personnel-dependent
OMA	1545.0	674.1	43.6	870.9	56.4
BP 2000 Operating Forces	817.0	435.8	53.3	381.2	46.7
BP 2100 Training Activities	120.0	0	0	120.0	100.0
BP 2200 Central Supply Activities	271.0	81.3	30.0	187.7	70.0
BP 2300 Major Overhaul and Maintenance of Materiel	157.0	157.0	100.0	0	0
BP 2400 Medical Activities	137.0	0	0	137.0	100.0
BP 2500 Army-Wide Activities	43.0	0	0	43.0	100.0

TABLE 6

Classification Sensitivity Analysis: Force-Dependent OMA, by Type of Dependency, Ranked by Dollar Magnitude

Budget program	Type of dependency	Millions of dollars	Percent of force-dependent
Total		1545.0	100.0
BP 2000 Operating Forces	Materiel	435.8	28.2
BP 2000 Operating Forces	Personnel	381.2	24.7
BP 2200 Central Supply Activities	Personnel	189.7	12.2
BP 2300 Major Overhaul and Maintenance of Materiel	Materiel	157.0	10.2
BP 2400 Medical Activities	Personnel	137.0	8.9
BP 2100 Training Activities	Personnel	120.0	7.8
BP 2200 Central Supply Activities	Materiel	81.3	5.2
BP 2500 Army-Wide Activities	Personnel	43.0	2.8

TABLE 7

Classification Sensitivity Analysis: Materiel- and Personnel-Dependent OMA Ranked by Dollar Magnitude

Budget program	Materiel-dependent OMA		Budget program	Personnel-dependent OMA	
	In millions of dollars	In percent		In millions of dollars	In percent
Total	674.1	100.0	Total	870.9	100.0
BP 2000 Operating Forces	435.8	64.6	BP 2000 Operating Forces	381.2	43.8
BP 2300 Major Overhaul and Maintenance of Materiel	157.0	23.3	BP 2200 Central Supply Activities	189.7	21.8
BP 2200 Central Supply Activities	81.3	12.1	BP 2400 Medical Activities	137.0	15.7
			BP 2100 Training Activities	120.0	13.8
			BP 2500 Army-Wide Activities	43.0	4.9

TABLE 8

Disaggregated Activities and Estimated Budget Totals for BPA 2020 and BPA 2030

Activity	Estimated cost, millions of dollars	Type of dependency	
		Materiel	Personnel
Total	518.2		
Direct support maintenance (includes 2009–9040)	391.0	×	
General supplies	57.0	×	×
POL	33.0	×	
OMA materiel	23.8	×	×
Travel	13.4		×

TABLE 9

Force-Dependent Activities Ranked by Dollar Magnitude per Military Man

Activity	AMS account	Total account force-dependent, millions of dollars	Force-dependent dollars per military man
Maintenance of Facilities (Active Only)	2009–9030	221.1	342
Stock-Store and Issue		217.2	145
Central Supply Activities	2200	189.7[a]	—
Post Supply	2000–9050.11	27.5[a]	—
Medical Activities	2400	137.0	143
Operation of Schools	2110	99.3	—
General Supplies	2020 and 2030	57.0	100
Local Headquarters and Command Administration	2009–9010	21.9	34
Replacement Training in US Army Training Centers	2150	20.7	24
Travel	2020 and 2030	13.4	23
OMA Materiel	2020 and 2030	23.8	20
Other Administrative Services	2540	16.3	17
Major Field Command Headquarters	2520	13.5	14
Laundry and Dry Cleaning Services	2009–9050.4	8.3	13
The Army Food Program	2009–9050.5	8.2	13
Army-Wide Finance and Audit Services	2580	9.5	10
Recruiting and Other Personnel Support	2530	3.7	4
Totals		870.9	902

[a]Components of activity.

COST-ESTIMATING RELATIONS

The analytical tool used in cost analysis for translating measurement data to dollar cost is the cost-estimating relation (CER). A CER is defined as any estimating relation used to translate physical resources or activity measurement data into costs.

Well-constructed CERs used within their intended context provide reasonable cost approximations; naively constructed and/or misused CERs can lead to erroneous results. It is important to consider whether the CERs should be based on the latest available data, whether linear cost functions are descriptive of the activity being estimated, whether the activities are at a level of full employment, and whether there are discontinuities in the cost function.

CERs can greatly reduce the amount of specification required for men, materiel, and activities for costing the force change. Of course the amount of specification necessary for cost analysis depends on the problem and the type of answer sought; highly aggregated CERs developed for one cost problem will not be applicable to another cost problem if the second problem requires more detail than the aggregate CERs can estimate.

Where cost data exist at the minimum required level of detail there is no necessity to use an estimating relation; where such detail is not required, however, a CER can be used to reduce the specification effort.

The method used in this paper for the development of CERs is as follows:

(a) Restructure the set of classified accounts (see Table 1) according to appropriate force-dependent categories (see Table 2). Each of these new categories (activities) is a homogeneous force-dependent activity with the same variables throughout. (Variables are explained in b.) These new categories are connected with OMA activities via the latter's AMS codes (shown in cols 2 and 3 of Table 2).

(b) For each force-dependent activity identify those variables that (1) are affected by a force change and (2) result in changes in the force-dependent activities. For any one activity there can be several variables leading from the force change to the activity. These variables might be represented as follows.

Force Change → Intermediate Variable → Independent Variable → Force-Dependent Activity

The arrow indicates the logical or temporal direction of influence of a force change.

(c) Determine the coefficient (or more generally, conversion relation) that converts from values of an independent variable to the OMA cost of the force-dependent activity. If required, also determine the conversion relation from intermediate to independent variable. This can be done with either aggregate or detailed data.

When aggregate data are used, the process is to divide the total dollar cost of a force-dependent activity by the total value of the corresponding independent variable. An example of this occurs in Table 10 in which the coefficient of 0.04 (repair parts cost/total materiel cost) is determined from the aggregate of a wide variety of materiel items. (In this case the independent variable is a dollar value itself; in other cases, it may be men or tons.)

Regression analysis of more detailed data amounts to regressing individual cost quantities onto quantities of the independent variable so that the

TABLE 10

FY63 Financial Inventory and Stock Fund Data

Materiel item	Financial inventory in hands of troops, dollars	Stock fund OMA repair-parts issue, dollars	Annual repair-parts cost to inventory value ratio
Total	7,704,973,000	296,800,000	0.04
Missiles	1,606,319,000	63,500,000	0.04
Signal	1,326,000,000	63,000,000	0.04
Tactical vehicles	1,285,952,000	—	—
Combat vehicles	2,027,700,000	—	—
Commercial support vehicles	259,853,000	—	—
Artillery	110,646,000	—	—
Small arms	236,342,000	—	—
Engineer and quartermaster	852,161,000	—	—

activity cost is expressed as a function of the independent variable. As in the aggregate method, intermediate variables are dealt with separately.

The primary method of developing CERs in this paper is the derivation of coefficients from aggregations of financial data as discussed above; however, this is not the only method of developing CERs. Other methods, such as regression analysis, are used when applicable data are available. A flow chart for data sources and computational procedures employed in this paper is shown in Fig. 2.

Because the analysis presented in this paper is strongly dependent on data, it is necessary to discuss significant aspects of the use of data for the classification analysis, sensitivity analysis, and derivation of CERs. A comprehensive discussion of Army data sources and their applicability to this analysis and of data requirements for cost analysis is outside the scope of this paper.

The Use of Data

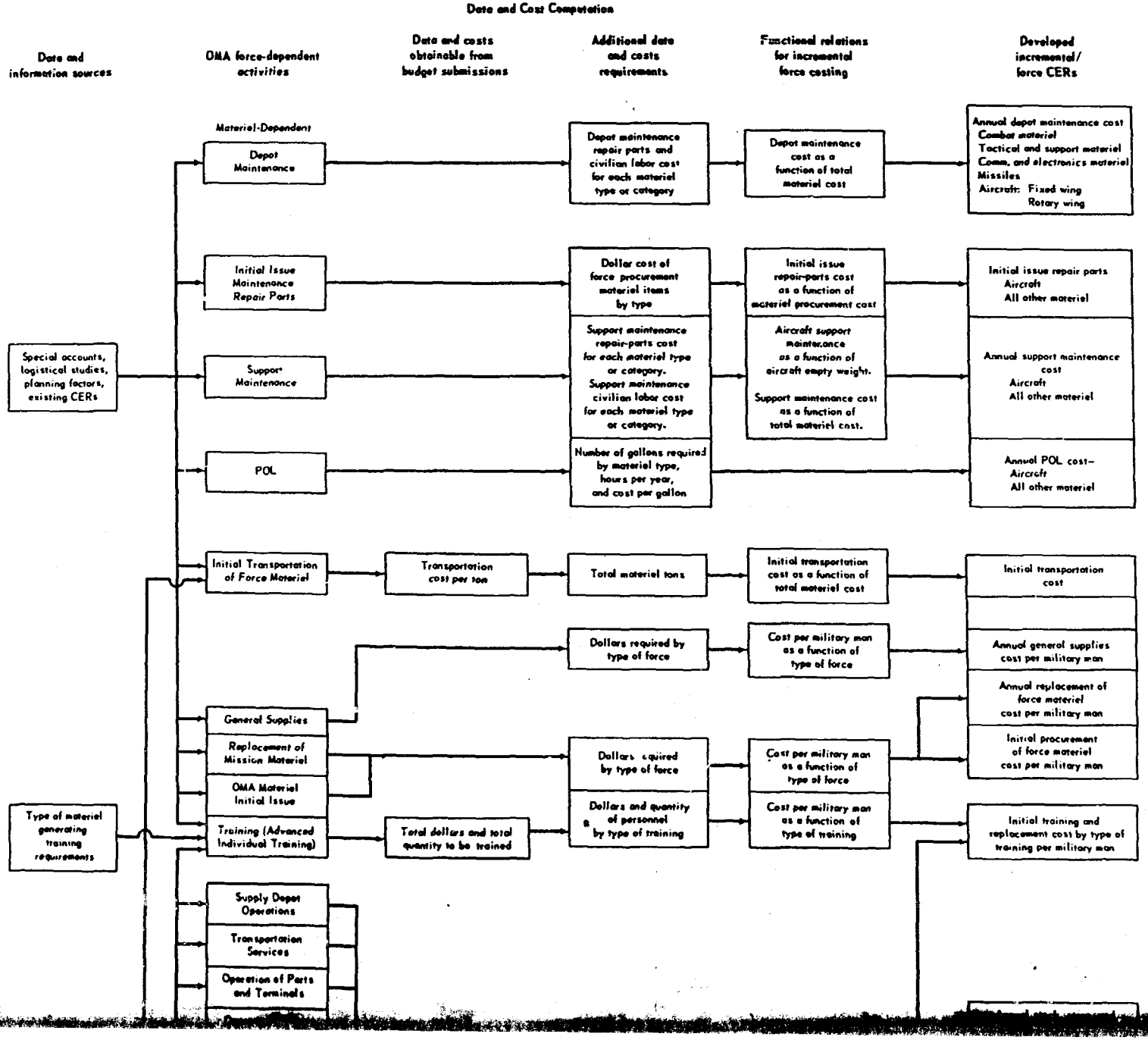
A previous section described how the accounting activities of the AMS fiscal code structure can be used for determination of force-dependent OMA activity categories. An integral part of the classification process is the introduction of the data that eventually will have to be used for measuring and costing these activities with respect to an incremental force. The amount of detail to be employed in the classification process and hence in the costing process deserves consideration. The more specific and complete data are more useful generally for purposes of analysis. Data can always be aggregated but rarely disaggregated. With data of appropriate specificity, similarities or differences among subelements or activities can be determined.

Data Sources

Most governmental and nongovernmental financial accounting systems are designed for audit and financial reporting; they were not developed and are not organized to provide the kinds of cost data required for planning. For planning purposes, management requires incremental cost data for each major output or end product. It is implicit in incremental cost data that fixed and variable costs are separated and that joint costs are identified with the applicable end products.

Financial accounting systems are usually total cost systems without end-product identification and usually have unallocated joint costs. A financial accounting system can be employed as a base for a crude cost-data system for managerial planning; it can never substitute for a separate cost-data system designed specifically for managerial planning.

Although the Army has a Five-Year Force Structure and Financial Program (FYFSFP), as shown in Fig. 3, the FYFSFP does not provide the necessary framework for cost analysis of an incremental force for the following reasons: (a) by design, the General Support Program (Program 7) shows joint costs, unallocated to the combat force programs (Programs 2 and 3); (b) command and geographical area funding streams include only funds spent by the command or geographical area, so there is a joint cost problem of allocating those funds to support the forces of the combat programs in one command or geographical area which are spent by another command or geograph-


Data and Cost Computation
Data and information sources
OMA force-dependent activities
Data and costs obtainable from budget submissions
Additional data and costs requirements
Functional relations for incremental force costing
Developed incremental/ force CERs
Materiel-Dependent
Depot Maintenance
Depot maintenance repair parts and civilian labor cost for each materiel type or category
Depot maintenance cost as a function of total material cost
Annual depot maintenance cost
Combat materiel
Tactical and support materiel
Comm. and electronics materiel
Missiles
Aircraft: Fixed wing
Rotary wing
Initial Issue Maintenance Repair Parts
Dollar cost of force procurement materiel items by type
Initial issue repair-parts cost as a function of materiel procurement cost
Initial issue repair parts
Aircraft
All other materiel
Special accounts, logistical studies, planning factors, existing CERs
Support Maintenance
Support maintenance repair-parts cost for each materiel type or category.
Support maintenance civilian labor cost for each materiel type or category.
Aircraft support maintenance as a function of aircraft empty weight.
Support maintenance cost as a function of total materiel cost.
Annual support maintenance cost
Aircraft
All other materiel
POL
Number of gallons required by materiel type, hours per year, and cost per gallon
Annual POL cost–
Aircraft
All other materiel
Initial Transportation of Force Materiel
Transportation cost per ton
Total materiel tons
Initial transportation cost as a function of total materiel cost
Initial transportation cost
Dollars required by type of force
Cost per military man as a function of type of force
Annual general supplies cost per military man
General Supplies
Replacement of Mission Materiel
OMA Materiel Initial Issue
Annual replacement of force materiel cost per military man
Initial procurement of force materiel cost per military man
Dollars required by type of force
Cost per military man as a function of type of force
Type of materiel generating training requirements
Training (Advanced Individual Training)
Total dollars and total quantity to be trained
Dollars and quantity of personnel by type of training
Cost per military man as a function of type of training
Initial training and replacement cost by type of training per military man
Supply Depot Operations
Transportation Services
Operation of Ports and Terminals

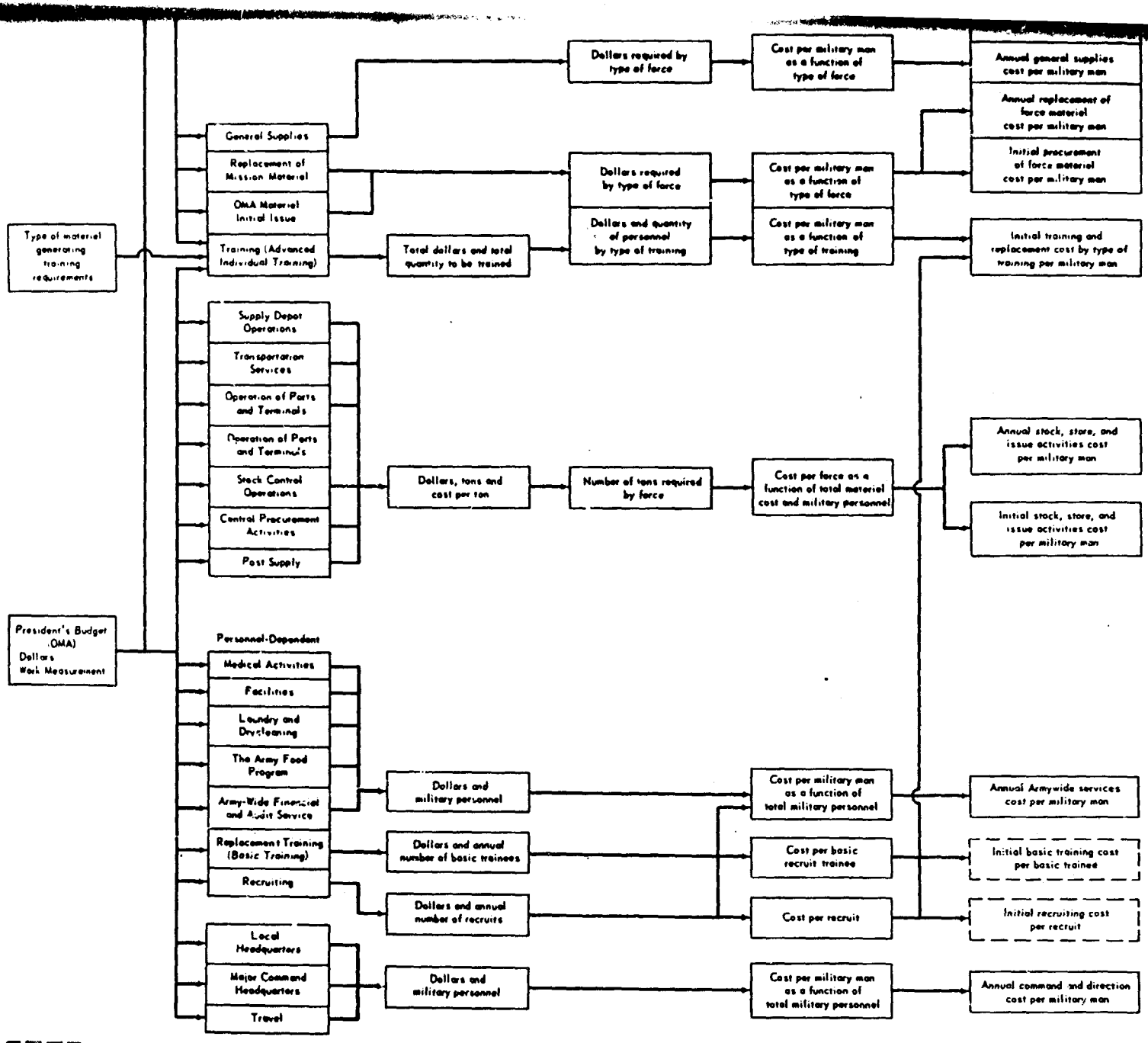


Fig. 2—Development of Incremental Force OMA CERs

a. The Programs of the FYFSFP

Programs

Program 1	Strategic Retaliatory Forces (not used by the Army)
Program 2	Continental Air and Missile Defense Forces
Program 3	General Purpose Forces
Program 4	Airlift and Sealift Forces
Program 5	Reserve and Guard Forces
Program 6	Research and Development
Program 7	General Support

b. Data Format of the FYFSFP

Program Element Code 30101061 Infantry Divisions

	1964	1965	1966	1967	1968	1969
Forces	Location					
Inf Div	Pacific		(number)			
Inf Div	CONUS		(number)			
Research and Development			(dollars)			
Total Research and Development			(dollars)			
Investment						
PEMA			(dollars)			
Total Investment			(dollars)			
Operations						
OMA, BP 2000			(dollars)			
Military Personnel Army			(dollars)			
Total Operations			(dollars)			
Total TOA			(dollars)			
Military Manpower			(strength)			
Active Service Officers						
Active Service Enlisted						
Total Military Manpower						
Civilian Manpower			(strength)			
Civilian Direct Hire, US						
Civilian Direct Hire, Foreign						
Total Civilian Manpower						
Total Manpower						

Fig. 3—Format of the Five-Year Force Structure and Financial Program, pre-FY68

ical area; and (c) changes to the FYFSFP are budget-account dollar totals and the specific force-related OMA activity causing the cost change are not identified in the FYFSFP format.*

In the search for a primary data source for use in this study, it was found that historical budget data and the reported budget execution data lacked accounting consistency. When multiple linear regression time series analysis was attempted, data for only a limited number of years could be obtained or were applicable (data from before or during the Korean War do not reflect the Army of the middle and late 1950's up to today). For the limited number of years that could be observed, quarterly analysis was explored but was found to be unsatisfactory because quarterly data reflected the annual funding patterns of an activity rather than independent observations of the activity. Time series data had the further limitation that costs can change from fiscal year to fiscal year due to (a) changes in the institutional structure of the Army, e.g., reorganizations, consolidations, opening or closing of installations; (b) passage of public laws, e.g., civilian pay increases; and (c) increases or decreases in activity of the economy, e.g., inflation, deflation, changes in taxes, wage rates, and tariffs.

To measure as nearly as possible these cost changes and more importantly to reflect the Army's OMA requirements, a continuing reappraisal must be made of the force-dependent activity categories, and the applicable cost estimates of these force-dependent activities must be recomputed as new data become available that reflect these changes.

Note, however, that the classification method enables the treatment of a large amount of detailed data and information. The ability to structure appropriately a large volume of data and information results in more accuracy than a purely statistical analysis of aggregated data and information.

The primary data sources selected for the classification of OMA activity analysis and the cost estimate computations are the President's Budget submission[2] and the Command Operating Budget (COB)[3] (current at the time the research was undertaken). The budget submissions are in the form of the financial accounting system used by the Army for formulating budgets, accounting for funds, and reporting budget executions. These sources reflect, for the purpose of planning-cost estimation, the current institutional structure of the Army; they are also the best available reflection of prices and present requirements (questions as to the adequacy of the current institutional structure and requirements are outside the scope of costing).

The President's Budget did not provide all the work measurement information and cost data necessary for determining activity cost for use in incremental force costing. Many ancillary data sources were sought to provide information and data not presented in the President's Budget. These data sources included stock fund expenditure data, Army planning factors, previously developed CERs, special Army publications, and RAC studies as well as other data sources. The use of each of these ancillary sources is documented as it is used in the cost estimation presented in Chap. 3. Where more detail was needed, ancillary historical data were necessary to fill missing gaps; there is an unavoidable time lag in the preparation of such data.

*Subsequent to the completion of this research the FYFSFP was renamed the Five Year Defense Program (FYDP) and restructured from seven to nine programs.

Chapter 3

COST ESTIMATION AND THE DEVELOPMENT OF OMA CERs

INTRODUCTION

In this chapter a set of OMA CERs for every OMA activity classified as force dependent in Chap. 2, except MOS training, is developed to show by example the process of analysis.

To define in advance every type of cost problem that could be encountered is impossible; a set of ready-made CERs applicable to all Army cost problems cannot be developed. Many CERs must be especially selected and tailored to fit the question that each individual costing problem is to answer.

The CERs developed in this paper were derived primarily for force-structure-change cost problems for brigade-sized forces including necessary support, i.e., involving 10,000 or more military men. CERs based on military men in the force change probably have a fairly wide application to other types of cost problems. The materiel-related CERs are highly aggregated; although satisfactory for force-structure-change-type problems, they are not detailed enough for cost-effectiveness studies involving alternative hardware items or weapon systems.

Where the number of alternatives that require costing is large, automated costing is usually considered. An OMA version of "An Individual System/Organization Cost Model (ISOC)"[4,5] has been developed, and the CERs developed in this paper (TP-242) have been employed in the ISOC model.

SUMMARY OF FORCE-DEPENDENT CERs

The OMA annual operating CERs are shown in Table 11. It shows the CERs for each activity and the specification variables for computing the annual operating costs of an incremental force. Table 12 shows the personnel component annual operating CERs for Armywide Services and Command and Direction. The OMA initial investment CERs are shown in Table 13.

The specification variables that were employed to derive these CERs are the following:

(a) The total value of the incremental force materiel; this is the sum of the materiel value at standard cost (i.e., current Army catalog cost) of initial-issue materiel items (excluding replacement/consumption, maintenance float and wartime stockage). The force's materiel requires further separation into

TABLE 11

OMA Incremental Force-Dependent Annual Operating CERs

Type of force dependency	Factor CERs and specification variables
Materiel Related	
Maintenance	
Support Maintenance Annual Repair-Parts Cost	
All Materiel Items (except aircraft)	0.04 × sum of the force materiel items cost at standard cost
Aircraft	
Fixed-wing	No developed CER
Rotary-wing	Cost per flying hour = 5.20 + 0.0042 × helicopter empty weight in pounds
Support Maintenance Civilian Labor	
All Materiel Items	0.214 × sum of computed support maintenance repair-parts cost
Depot Maintenance	
Combat Vehicles	0.00446 × sum of force materiel items cost at standard cost
Tactical and Support Vehicles	0.01056 × sum of force materiel items cost at standard cost
Electronics and Communication equipment	0.01027 × sum of force materiel items cost at standard cost
Missile Systems	0.01155 × sum of force materiel items cost at standard cost
Aircraft	
Fixed-wing	0.00382 × sum of force materiel items cost at standard cost
Rotary-wing	0.01686 × sum of force materiel items cost at standard cost
Residual Depot Maintenance Cost factor	0.274 × calculated direct depot maintenance cost (to be added to the calculated direct depot maintenance cost)
POL	
All Material Items (except aircraft)	
Aircraft	Cost per flying hour
Fixed-wing	No developed CER
Rotary-wing	No developed CER
Materiel and Personnel Related	
General Supplies, dollars	100 per military man
Replacement of OMA Materiel, dollars	20 per military man
Training	No developed CERs
Stock, Store and Issue Activities	
CONUS, dollars	168 × annual consumption tons
Overseas, dollars	270 × annual consumption tons
Worldwide, dollars	209 × annual consumption tons
	(Estimate of annual consumption tons = 0.7 × military personnel + 0.00005 × total force materiel cost)
Personnel Related	
Armywide services, dollars[a]	566 per military man
Command and Direction, dollars[a]	71 per military man

[a]See Table 12 for component CERs.

TABLE 12

Annual Operating Subactivities and Their Force-Dependent Costs for Armywide Services, and Command and Direction

Subactivity	Cost per military man[a], dollars
Armywide services	566
Medical Activities	(143)
Maintenance of Active Facilities	(342)
The Army Food Program	(13)
Laundry and Dry Cleaning Services	(13)
Recruiting and Other Personnel Support	(4)
Replacement Training in US Army Training Centers	(24)
Other Administrative Services	(17)
Army-Wide Finance and Audit Services	(10)
Command and Direction	71
Local Headquarters and Command Administration	(34)
Major Field Command Headquarters	(14)
Travel	(23)

[a]Numbers in parentheses are breakdowns of the totals.

TABLE 13

OMA Incremental Force-Dependent Initial Investment CERs

(Nonrecurring costs)

Type of force dependency	Factor/CERs and specification variables
Materiel related	
Initial Issue of Repair Parts	
All materiel items (except aircraft)	10% × materiel investment cost
Aircraft	20% × investment cost of aircraft materiel items
Transportation of Force Materiel	
CONUS, dollars	35 × the number of tons of force materiel
CONUS to Overseas, dollars	120 × the number of tons of force materiel
Worldwide, dollars	69 × the number of tons of force materiel
	(Estimate of the number of tons of force materiel = 340 + 0.000335 × total force materiel cost)
Materiel and Personnel related	
Procurement of OMA, dollars	200 per military man
Initial Training	No developed CERs
Stock, Store, and Issue Activities	
CONUS, dollars	249 × annual consumption tons
Overseas, dollars	351 × annual consumption tons
Worldwide, dollars	290 × annual consumption tons
	(Estimate of annual consumption tons = 0.7 × military personnel + 0.00005 × force materiel cost)
Personnel related	
Initial Basic Training, dollars	91 per basic trainee
Initial Recruiting, dollars	67 per basic trainee

the following materiel categories: Weapons, Combat Materiel Items, Tactical Materiel Items, Support Materiel Items, Electronic and Communication Items, Missile Ground Support Items, Aircraft (Fixed wing, Rotary wing).

(b) The total number of military personnel in the incremental force.

(c) Materiel activity rates (aircraft flying hours, vehicle-miles/hours).

OPERATING FORCES, BP 2000

Operating Forces (BP 2000) is the largest dollar budget program of OMA. The activities funded within this program are directly associated with the operation and maintenance of combat, combat-support, and service-support units. This budget program is very sensitive to the materiel and personnel resource implications of a force change. The direct operating costs of combat, combat-support, and service-support units are contained in two highly aggregated budget project accounts: Operating Forces (less ARADCOM), BPA 2020, and ARADCOM, BPA 2030.

Operating Forces are separated into the two accounts for consistency of the AMS with the program structure of the FYFSFP (the correspondence between the two structures is detailed in "Program Element/Army Management Structure Correlation Tables"[6]). Included within these two BPAs are costs for materiel-dependent support maintenance and POL, materiel- and personnel-dependent replacement of OMA equipment and general supplies, and personnel-dependent travel [relating to the unit, not permanent change of station (PCS) travel, which is funded by the Military Pay appropriation].

Since the AMS does not structure BPAs 2020 and 2030 in an activity context, it was necessary to disaggregate the activities of these two BPAs for cost analysis and development of CERs. The disaggregated activities of BPAs 2020 and 2030 that have been determined to be force-dependent are shown in Tables 1, 2, and 9.

The following analysis presents CERs for each of the activities of BPAs 2020 and 2030. The CERs were developed without making a distinction between BPA 2020 and BPA 2030 funding for each of the force-dependent activities.

The Operation and Maintenance of Facilities (OMF), BP 2009, is discussed in the final section of the chapter.

Support Maintenance: Annual Repair-Parts Cost

Support maintenance is defined as all user maintenance up to depot maintenance: organizational, direct support, and general support.

The CERs developed in this section are based on a number of budget activities that include BPAs 2020, 2030, 2009-9040, and, for aircraft, CA 2350.15.

For estimating the cost of Army support maintenance, two materiel groupings have been made: all materiel items (except aircraft), and aircraft; aircraft are further subdivided into fixed wing and rotary wing.

All Materiel Items except Aircraft. In a previous study[7] on OMA maintenance costing, a CER was developed for estimating the annual repair-parts cost of organizational, direct-support, and general-support maintenance for

combat tactical and support vehicles. The maintenance-cost data were obtained from five ORO-RAC publications[8-12] on the economics of maintenance. Fourteen different materiel items were studied, and the mean lifetime annual repair-parts cost was calculated and compiled from the five studies. The results and data used for developing this CER are shown in App A.

At the time this CER was developed, it was intended to be one of a set of maintenance CERs covering Army support maintenance. Other CERs were to include communication materiel, surface-to-air and surface to-surface missile ground equipment, and a residual CER to include all remaining materiel.

It was expected that The Army Equipment Records System (TAERS) would be able to provide the data required for developing these additional CERs. However, TAERS data have not been summarized and published, and other estimating techniques, even though less sophisticated, had to be devised.

This earlier work provides a framework for the support-maintenance CERs developed in this study. First, a high correlation was established between the cost of the materiel item and the cost of annual support maintenance of the materiel item. Second, magnitude of the annual support-maintenance cost was determined.

Army Stock Fund[13] and Financial Inventory[14] data were used as the best and only complete sources for developing support-maintenance CERs. A major disadvantage of stock-fund data is that the stock-fund designations (the nine repair-parts stock funds and their FY63 issues in dollars are given in App A) shown in Table 10 could not be reconciled with those in the Army Materiel Plan (AMP) except for three categories: signal, aircraft, and missiles. The inability to match the other data prevented further disaggregation and sensitivity testing of support-maintenance costs within AMP[15-18] categories.

The CER developed from the data shown in Table 10 was computed by dividing the dollars in the column, "stock fund OMA repair-parts issue," by the dollars in the appropriate materiel category of "financial inventory in the hands of the troops." The result of this division is the annual support-maintenance repair-parts CER. From this division a factor of 0.04 was found; rounding this answer the CER is "all materiel items (except aircraft) 0.04 × sum of the force materiel items (at standard cost)."

The materiel items used for developing the earlier support-maintenance CER were of the high-usage, high-density, and/or high-cost type, which contributes sizably to the total of Army maintenance costs. On the other hand, materiel items of a low-usage or less complex type require less maintenance than those used in the sample. For these reasons a total support-maintenance CER for all materiel items (except aircraft) would be expected to be of a smaller magnitude than the previously developed CER.

Aircraft.

Rotary-wing aircraft. A CER was developed for estimating the organizational, direct-support, and general-support repair-parts cost per flying hour for rotary-wing Army aircraft (helicopters).

The derived CER was found to be 0.0042 times the empty weight, in pounds, of the helicopter for which the estimation is made, plus $5.20.

The CER was developed by regression analysis from support-maintenance repair-parts cost data (dependent variable) for six Army helicopters, as reported in Army Pamphlet 335-3,[20] and the empty weight (independent variable)

of the six helicopters, obtained from the "Weapons Dictionary."[21] The specific aircraft and data used are given in App A.

The regression equation takes the form

$$Y = b_0 + b_1 X$$

where Y = organizational, direct-support, and general-support repair-parts cost per flying hour

b_0 = the Y intercept

b_1 = the slope of the regression line

X = the empty weight of the helicopter, in pounds

Calculation of the regression parameters yields

b_0 = 5.20

b_1 = 0.0042

r = 0.926 coefficient of correlation

r^2 = 0.857 coefficient of determination

S_{b_0} = 13.90 standard error of b_0

S_{b_1} = 0.0008 standard error of b_1

Standard error of the estimate = $12.66

Substituting the calculated parameters into the general regression equation yields

$$Y = \$5.20 + 0.0042X$$

The annual operating cost for support maintenance of rotary-wing aircraft is

$$Y = [(\$5.20 + 0.0042X)\ (\text{annual flying hours})]$$

The data used to develop the rotary-wing aircraft organizational, direct-support, and general-support repair-parts cost per flying hour were given as arithmetical means. These data gave no variance statement, aircraft sample size, or total flying hours for the computed means. These gaps in data make it impossible to state the behavior of cost per flying hour at different levels of flying hours (current reported Army annual flying hours range from 200 to 300 hr/year per aircraft).

Fixed-wing aircraft. The possibility of developing a predictive CER for estimating the organizational, direct-support, and general-support repair-parts cost per flying hour for Army fixed-wing aircraft was considered.

During the period of this research, numerous discussions and evaluations were under way within the Army and between the Army and Air Force, with respect to the speed and weight envelope for Army fixed-wing aircraft.

It was concluded that a fixed-wing aircraft maintenance CER should not be developed until the results of these discussions were fully implemented. Then it should be possible to develop a maintenance CER for fixed-wing aircraft similar to the maintenance CER for rotary-wing aircraft, e.g., empty weight as the independent variable and repair-parts cost as the dependent variable.

Initial-Issue Repair Parts. Two factors, representing current policy, have been used for estimating the initial-issue repair-parts cost associated with a force change. They are expressed as a percentage of the force-change materiel investment cost, exclusive of replacement/consumption, maintenance float, and wartime stockage:

All materiel items, except aircraft	10%
Aircraft	20%

Additional research is required to establish and document the cost of initial-issue repair-parts cost of a force change. A related problem is that the funding of initial-issue repair parts has shifted back and forth between the OMA and PEMA appropriations. The current policy is to fund repair parts from OMA; however, there are exceptions.

POL

The following procedure was developed for estimating POL costs of current materiel items rather than future materiel items. For estimating POL requirements of future materiel items, primarily aircraft systems, specific CERs are required and should be developed from the design characteristics of the materiel.

All Materiel Items except Aircraft. To develop a POL estimation technique for all materiel items excluding aircraft, a sample of 33 TOEs was established. The materiel items for each TOE that requires POL for operation were enumerated from "TOE, Costout of on-File SRCs."[22] For each type of materiel item enumerated in the sample TOEs, the gallons of POL consumed hourly were calculated by multiplying the per-hour consumption rates found in FM 101-10.[23] For estimating the POL gallons per hour, POL-consuming items were grouped in four categories, and means were computed as shown in Table 14 (see App A for TOEs sampled and the data).

TABLE 14

Materiel Categories and Their Mean POL Consumption, Used To Estimate POL Expenditure

Materiel category	Consumption, mean POL gal/hr
Tactical: wheeled vehicles (trucks)	2.0
Support: engineer equipment	7.0
Combat: light tracked vehicles (under 30,000 lb)	4.0
Combat: heavy tracked vehicles	15.0

The equation for estimating the annual cost of POL for all materiel items (except aircraft) is:

POL cost = (mean gallons of POL per hour) x (number of materiel items) x (mean hours per year) x (cost of POL per gallon)

Aircraft. No CERs were developed for either fixed- or rotary-wing Army aircraft. The primary reason is that the current Army aircraft inventory contains both piston-engine aircraft and turbopropeller (propjet) aircraft. These two different engine types use different fuel and must be enumerated as two different populations for analysis. If the current inventory is segmented into four samples by aircraft type and engine type, the resulting samples are too small for meaningful analysis.

The POL gallons per flying hour for the fixed- and rotary-wing aircraft currently in the Army aircraft inventory are given in App A. These POL consumption data were extracted for each aircraft type from a RAC working document, "Aviation Cost Data."[24]

General Supplies

The cost of general supplies was considered for this analysis to depend on both the materiel and personnel of a force change. However, since the cost of general supplies for a force change cannot be empirically determined from currently available data, it was necessary to make an estimate of the cost.

General supplies were estimated as $100 per military man from FY63 Stock Fund data and an analysis of the BPAs 2020 and 2030, but were kept separate from the other per-military-man cost factors pending further study.

OMA Materiel

The cost of OMA materiel required with respect to force changes is both an annual operating cost and an initial investment cost.

For the initial investment cost a CER was previously developed and documented in an unpublished RAC paper, "TOE Equipment Cost-Estimating Relations—A Preliminary Investigation."[25]

The CER is the median per capita cost of OMA materiel derived from a sample of TOEs (listed in App A). This CER gives a force-dependent initial investment cost of $200 per military man.

The replacement (replacement/consumption) of this equipment is an annual operating cost and it is assumed that 10 percent of the total OMA materiel is replaced by the force each operating year. Modifying the above investment cost CER yields a force-dependent cost of $20 per military man per year.

Travel and Transportation of Personnel

Travel and transportation of personnel is a personnel-dependent activity directly attributed to force changes. From FY66 COB data[3] a cost of $23 per man was computed. For calculating the force-dependent-cost-per-military-man factor, the budget dollars for FY66 were summed from BPA 2020 and BPA 2030 for travel and transportation of personnel (object class 21), and the total dollar sum was divided by the number of military men funded by the two activities. The FY66 data are shown in the accompanying tabulation.

Object class 21	Budget allocation, dollars	Military men	Force-dependent cost per military man, dollars
BPA 2020	12,374,100	544,420	
BPA 2030	1,057,000	26,010	
Total	13,431,100	570,430	23

TRAINING ACTIVITIES, BP 2100

Three BP 2100 activities were determined to be force dependent: Operation of Schools, BPA 2110; Replacement Training, BPA 2150; and OMF (Training Facilities, BPA 2109), which supports the first two activities.

Operation of Schools, BPA 2110

The determination of the training cost per unit, both initial training (investment) and annual replacement training (annual operating), for formal school training for some specified MOS, requires more detailed data relating to the specific kinds of activities and their costs, as related to school training, than are presented in budget data. Training costs of formal schooling and advanced unit training constitute a separate area for analysis; they are not covered in this general OMA analysis, nor has on-the-job training (OJT) been investigated.

Replacement Training in US Army Training Centers, BPA 2150

Replacement Training Cost. The cost of a replacement trainee is assumed to depend on the number of basic trainees. The determination of replacement cost per trainee consists of the cost of replacement training divided by the number of basic trainees.

The costs of two activities had to be subtracted from the total BPA 2150 dollars: (a) Reserve Officer Officers Training Corps (ROTC) basic camp and (b) Special Training and Enlistment Program (STEP). (STEP was not approved by Congress and was eliminated from the FY66 OMA appropriation.)

The number of basic trainees was computed as the average number of trainees for FY61-FY64 as obtained from "Selected Manpower Statistics."[26] (These data are shown in App A.) From the previously subtracted non-force-dependent data the cost of initial basic training was calculated as $91 per basic trainee. This cost is to be considered as an OMA investment cost.

Turnover Rate. The cost per trainee is not the annual force-dependent cost of replacement training per military man. Since every man in the Army is not replaced every year, a turnover rate is required to establish the cost per military man. The turnover rate was calculated by dividing the number of trainees by the total number of enlisted men in the Army. This turnover rate was calculated as the mean turnover rate for FY61-FY64 (actual data) as derived from Ref 26. (The President's Budget submission[2] shows basic trainees in man-years, and not actual number of trainees.) The 4-year average turnover rate was calculated to compensate for a 2-year data cycle, 1 year high, the next low, for inductions (draftees).

The computed mean turnover rate was found to be 0.266. The turnover rate multiplied by the cost per trainee gives an annual dependent cost per military man of $24. These data are shown in Tables 15 and 16.

Training Facilities, BPA 2109

The facilities costs of replacement training will have to be evaluated in the context of the size of the force addition; generalization is not possible because of the expandable characteristics of most replacement training centers.

TABLE 15

Data Used for Computing Replacement Training Turnover Rates[26]

Turnover rate data fiscal year	First enlistments and inductions	Total Army enlisted strength	Turnover rate
1961	176,345	758,701	0.232
1962	284,580	950,354	0.299
1963	186,133	867,614	0.214
1964	266,890	862,368	0.310
Four-year average	228,487	859,759	0.266

TABLE 16

Data Used for Computing Replacement Training Turnover Costs[2]

Category	Unit of measure
BPA 2150 Replacement training in US Army training centers, dollars	23,472,000
Less ROTC basic camp, dollars	88,000
Less special training and enlistment program, dollars	2,636,000
Total force-dependent costs, dollars	20,748,000
Total active Army basic trainees	228,487
Cost per trainee (initial basic training – OMA investment cost) BPA 2150 cost ($20,748,000/228,487), dollars	91
Active Army basic training turnover rate	0.266
Force-dependent cost per military man ($91 × 0.266) – annual operating, dollars	24

In cases of facilities expansion, prorating one-time facilities costs to the trainees will give erroneous results. Facilities, either annual operating or initial investment, for replacement training should be treated as a force-dependent cost but not necessarily on a per-man or -trainee basis.

CENTRAL SUPPLY ACTIVITIES, BP 2200

Central Supply Activities, as a budget program, consists of those activities essential to the operation and maintenance of a logistical system designed to support those Army forces currently deployed. The following activities funded by BP 2200 were determined to be force-dependent activities: Depot Facilities (OMF), Procurement Management, Depot Operations, Transportation, Port Terminal Operations. The specific AMS codes that relate these activities to the President's Budget submissions[2] are shown in Tables 1 and 2.

The force-dependent activities of this budget program relate to one another so it is possible to integrate these activities and their costs as a continuous flow of sequential activities. An additional cost must be added to the BP 2200 activities to complete the flow. The activity is Post Supply BPA

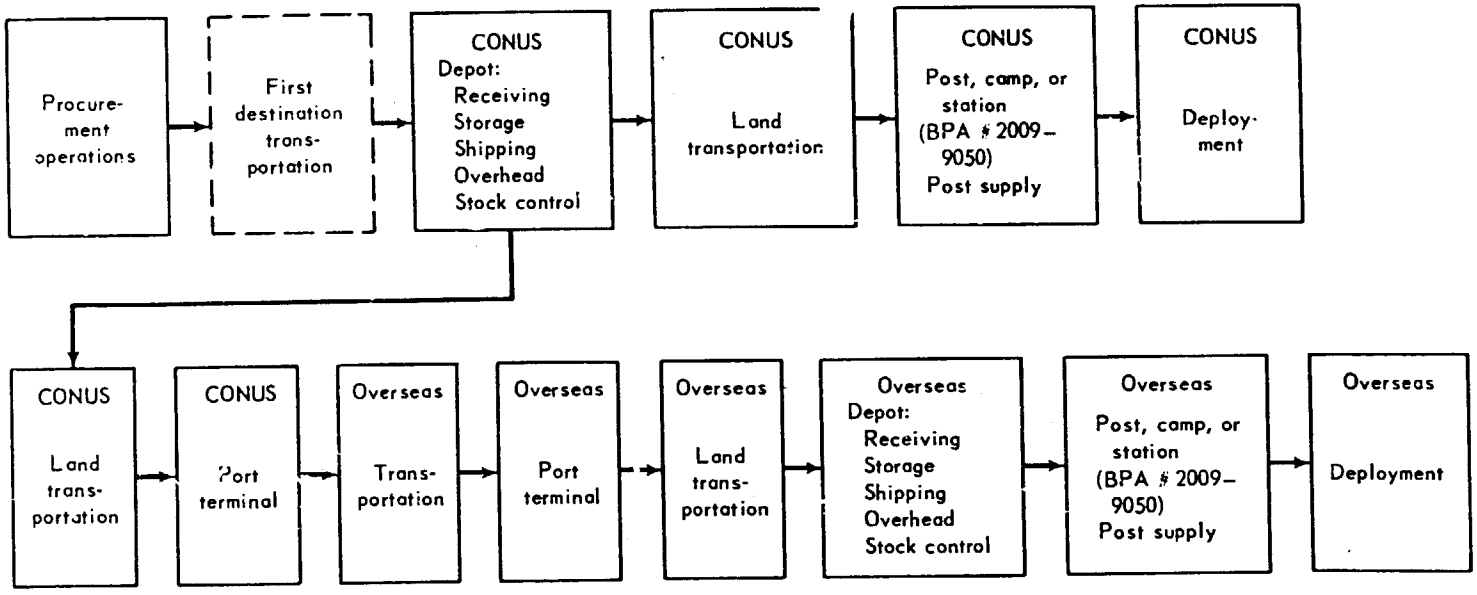


Fig. 4—Sequential Flow of Central Supply Activities

OMA activities PEMA activity

2009-9050, for which the cost is computed with the other 9000 activities in this paper. This sequential flow is expressed in tons and all costs are computed as the cost per ton.

Figure 4 depicts the sequential flow of BP 2200 force-dependent activities and provides the specification framework for cost estimation. The specification of the rate at which an activity can be expected to vary as a function of force changes is not verifiable empirically. All cost estimates were calculated as the average activity cost, with an assumption of the same distribution of expenditures, commodity mixes, and transportation distances. No attempt has been made to differentiate the overseas designation between specific geographical areas or theaters.

The specification of the amount of variability of the force-dependent activities and their cost estimation is described for each activity, within the framework of the AMS, in the following sections. The force-dependent activties and their associated costs are translated into cost-per-ton factors as shown in Table 17.

TABLE 17

Central Supply Activities Cost per Ton[2]

Activity	Measure of activity, Stons	Cost, dollars	Cost per Ston,[a] dollars
SCA 2210.1 Operation of Central Procurement Offices			20
SCA 2220.1 Supply Depot Operations			
CONUS			46
Receiving	995,000	13,555,000	(14)
Shipping	1,097,000	31,350,000	(29)
Storage	5,270,000	14,607,000	(3)
Overseas			17
Receiving	946,000	5,913,000	(6)
Shipping	1,028,000	7,989,000	(8)
Storage	1,258,000	4,230,000	(3)
SCA 2230.1 Inventory Management Activities			
2230.13 Stock Control	995,000	9,000,000	5
SCA 2250.1 Land Transportation			
CONUS	823,000	29,037,000	35
Overseas	4,248,000	25,795,000	6
SCA 2250.3 Sea Transportation			
Army Dry Cargo	2,087,840	114,885,000	55
SCA 2270.1 Operation of Ports and Terminals			
Cargo CONUS	1,952,000	31,292,000	16
Cargo Overseas	2,898,240	24,683,000	8

[a]Numbers in parentheses are breakdowns of total.

Operation of Central Procurement Offices, SCA 2210.1

It is estimated that Procurement Offices activity will change at a rate of 1 percent of the value of the materiel procured.[27] It is further estimated that 2 Stons of materiel are consumed per man-year as a total Army average, and 1 Ston of the 2 tons comprises the Army procurement requirement.[27] Con-

verting the 1-ton/man ear consumption to an average dollar value, $2000 per ton was determine as the value of materiel procured by Army Central Procurement Offices. From data in the FY66 President's Budget submissions[2] the cost per ton was calculated as $20 ($2000 x 0.01).

Initial issue and pipeline requirements on a worldwide basis (investment costs) are estimated from a sample of TOEs as $7000 of procurement per man-year, and the total cost is $70. This procurement adds 3 Stons at a cost of $23 per ton.

Supply Depot Operations, SCA 2220.1

The rate of change for Depot Operations is estimated on the basis of 1 Ston as the total inventory consumption per man-year through the depot system, again as a total Army average.

The specific activities occurring in the supply depots and applicable to this analysis are Depot Receiving, CA 2220.11; Depot Storage, CA 2220.14; Depot Issue (Shipping), CA 2220.15, and Depot Operations Direct Overhead, CA 2220.18.

For developing a cost per short ton for receiving, storage, and shipping, the direct overhead dollars were allocated to all the activities of SCA 2220.1 by the common cost-accounting procedure of proportional distribution, where direct overhead dollars are allocated to each activity in the same dollar proportion each activities-dollar proportion is of the total SCA 2220.1.

This procedure was applied for estimating supply depot operations for both CONUS and Overseas. Based on the FY66 President's Budget submissions,[2] CONUS supply depot costs were determined to be $46 per Ston (receiving $14, shipping $29, storage $3) and Overseas supply depot costs were $17 per Ston (receiving $6, shipping $8, storage $3).

As stated in the previous section on BPA 2210.1, investment costs were estimated as $7000 for average procurement per man-year. This procurement will add 3 Stons of supplies for processing in the depot system, arising from initial issue and pipeline requirements. The aggregated investment cost associated with these 3 Stons in CONUS is $109, consisting of 3 Stons received in a CONUS depot, $42 (3 tons x $14); 3 Stons stored, $9 (3 tons x $3); 2 Stons shipped to post, camp or station, $58 (2 tons x $29). A one-time cost for shipment of 1 of the 3 Stons, processed through an overseas depot is $17 (1 ton x $17).

Stock Control, CA 2230.13

Stock Control activities increase as a function of force changes. The amount these activities are expected to vary with force changes was estimated as one-half the total cost per ton as calculated from the FY66 President's Budget submissions.[2] The total cost per ton was determined to be $9; therefore $5 per ton is the computed cost of Stock Control activities.

No differentiation is made between CONUS and overseas costs, and there are no investment costs.

Transportation and Operation of Ports and Terminals

The amount of change in costs with respect to force changes for these two activities is related directly to Supply Depot Operations

Land Transportation, SCA 2250.1. In CONUS, Land Transportation is required for moving supplies and materiel from CONUS depots to posts, camps, and stations and for moving supplies and materiel from CONUS depots to CONUS ports of embarkation for overseas shipment. From data in the FY66 budget submissions,[2] the cost of moving 1 Ston was calculated as $35, which is an annual operating cost. From an analysis of the supply depot operations it was estimated that 2 Stons of supplies per man are shipped to posts, camps, or stations; therefore the cost for land transportation in CONUS is $70 ($35 x 2), which is an investment cost.

Land transportation overseas is required for moving supplies and materiel from ports of debarkation to overseas depots. Again, from data in the FY66 budget submissions,[2] the cost of moving 1 Ston was estimated as $6. The total land transportation cost, including shipment from the CONUS depot to the port of embarkation and from the port of debarkation to the overseas depot, is therefore $41 ($35 + $6) per ton, which is an annual operating cost.

One additional short ton is shipped overseas at a one-time, or investment, cost for transportation of $41 per ton.

Sea Transportation, SCA 2250.3. Sea transportation applies only to overseas shipments. A cost of $55 was computed from the FY66 budget submissions[2] for both annual operating and investment costs.

Operations of Ports and Terminals, SCA 2270.1. Operations of Ports and Terminals also applies only to overseas shipments. From the FY66 budget submissions[2] the cost per short ton* was estimated as $16 for CONUS ports and terminals and $8 for overseas ports and terminals. A total of these two costs results in an annual operating and investment cost of $24 per ton.

Summary of BP 2200 Costs

The annual operating and investment costs associated with BP 2200 are shown in Table 18. The table presents the cost per ton of each activity, in the order that the activity is displayed in the sequential flow of central suppiy activities in Fig. 4, except for post supply cost from CA 9050.11.

Table 19 summarizes the total BP 2200 annual operating and investment costs for CONUS, Overseas, and Worldwide geographical areas.

The Worldwide costs were computed by using the ratios of CONUS and Overseas military strengths to total Army strengths. Since the total Army average is 1 ton per man, these ratios can be expressed directly as tonnage ratios. The CONUS ratio was found to be 0.60 and overseas, 0.40. The formula thus becomes:

(CONUS cost per ton x 0.60) + (overseas cost per ton x 0.40)

In Table 20 the total cost per ton for stock, store, and issue activities are given for CONUS, overseas, and worldwide, for both annual operating and investment costs. Again the worldwide computation was made as previously described for Central Supply Activities, shown in Table 19.

Stock, store, and issue activities include Central Supply Activities, BP 2200, with the addition of Post Supply, SCA 9050.1.

*Data for this activity were given in measurement tons. To convert to short tons the number of measurement tons is multiplied by 0.40.

TABLE 18

Central Supply Activities Force-Dependent Costs[2]

Budget program	Annual operating cost per ton, dollars	Initial investment cost per ton, dollars
Cost per ton—CONUS	106	249
SCA 2210.1 Operation of Central Procurement Offices	20	70
SCA 2220.1 Supply Depot Operation (CONUS)	46	109
CA 2230.13 Stock Control	5	—
SCA 2250.1 Land Transportation (CONUS)	35	70
Cost per ton—Overseas	208	351
SCA 2210.1 Operation of Central Procurement Offices	20	70
SCA 2220.1 Supply Depot Operations (CONUS)	46	109
CA 2230.13 Stock Control	5	—
SCA 2250.1 Land Transportation (CONUS)	35	70
SCA 2270.1 Operation of Ports and Terminals (CONUS)	16	16
SCA 2250.3 Sea Transportation	55	55
SCA 2270.1 Operation of Ports and Terminals (Overseas)	8	8
SCA 2250.1 Land Transportation (Overseas)	6	6
SCA 2220.1 Supply Depot Operations (Overseas)	17	17

TABLE 19

CERs for Central Supply Activities, Annual Operating and Investment Costs[2]

Central supply activities	Cost, dollars per ton		
	CONUS	Overseas	Worldwide
Annual operations	106	208	147
Investment	249	351	290

TABLE 20

CERs for Stock, Store, and Issue Activities Annual Operating and Investment Costs[2,3]

Stock, store, and issue activities	Cost, dollars per ton		
	CONUS	Overseas	Worldwide
Annual operations	168	279	207
Investment	249	351	290

The costs of stock, store, and issue activities have been expressed so far as the cost per ton for each of the component activities. To estimate the annual consumption tonnage for a force change the following estimating equation has been developed:

$$\text{Annual consumption in tons} = (0.7 \times \text{number of military personnel}) + (0.00005 \times \text{total materiel cost})$$

The estimating equation was developed on the assumption that the annual tonnage consumption of a force change is determined by both the numbers of military personnel and the value of the materiel items in the proposed force change. It has been assumed that a military man consumes 0.7 tons/year, and the tonnage consumption that is materiel-related is based on the value of the materiel items. Since repair parts and POL are the primary materiel-related consumption tonnage and since both have been established as a function of the total materiel value, estimation has been made on this basis.

To compute the tonnage requirements for each dollar of materiel, TOEs were employed. A sample of 71 TOEs was drawn (see App A for list of TOEs and data used for the analysis). A worldwide consumption tonnage average of 1 ton/military man was applied to the 71 sampled TOEs to determine a control total. The total consumption tonnage for the 71 sampled TOEs was found to be 27,682 tons.

The military personnel-dependent tonnage was determined to be 19,377 tons (27,682 x 0.7) and the materiel-dependent tonnage was found to be 8305 tons.

The dollars of materiel value for these 71 TOEs were summed from data supplied in the Radford runs,[22] resulting in a dollar value of $171 million. Division of 8305 tons by $171 million yielded a coefficient of 0.00005 as the tonnage requirement for each dollar of materiel value.

Transportation of TOE Equipment

This activity is an investment cost only and is outside the previously described flow of sequential BP 2200 activities, though it is a BP 2200 activity.

Transportation of TOE equipment is an investment cost required for moving the materiel of the force from one location to another on a permanent change-of-station basis or for moving the required force materiel from depots to location where the TOE unit is to be organized. Sources of data not included in the President's Budget submissions[2] were required to determine the tonnage of materiel. For current TOEs this information is available, but for advanced systems and new TOEs tonnage data is not available, as materiel specification is usually not completely detailed. To meet the requirements for advanced-system and new TOE costing an estimating relation was developed for materiel tonnage.

The number of tons of materiel was obtained for 36 individual TOEs from RAC's Logistics Department (see App A for TOEs and data used for this analysis). These tonnage data were plotted successively against the dollar value of the TOE materiel obtained from the Radford runs[22] and against the number of military personnel authorized in their respective TOEs. From the plots a good relation was found to exist for both independent variables. Multiple correlation analysis was tried, using both materiel value and numbers of military personnel for a

TOE as independent variables and TOE tonnage as the dependent variable. The coefficient of correlation r was computed as 0.953, military men were found to be correlated to tons (r = 0.898), and materiel value to be correlated to tons (r = 0.941). Since the inclusion of the personnel variable added so little to the explanation it was dropped in favor of the two-variable linear form of materiel value and tons. The regression equation takes the form

$$\hat{Y} = b_0 + b_1 X$$

where $\hat{Y}$ = tons of materiel
b_0 = the Y intercept
b_1 = the slope of the regression line
X = the standard cost of the materiel items

Calculation of the regression parameters yields

b_0 = 340
b_1 = 0.000335
r = 0.941, coefficient of correlation
r^2 = 0.885, coefficient of determination
S_{b_0} = 690, standard error of b_0
S_{b_1} = 0.000021 standard error of b_1
Standard error of the estimate = 688

Substituting the calculated parameters in the general regression equation yields

$$Y = 340 + .000335X$$

To determine the transportation costs per ton the same costs were used as those described in the previous section, "Transportation and Operation of Ports and Terminals." For CONUS the TOE transportation cost was calculated as $35 per ton. For CONUS to overseas movements the total cost is $120 per ton. The worldwide average is $69 per ton. The worldwide average was calculated as described for the other BP 2200 worldwide averages, i.e., (CONUS cost per ton x 0.60) + (Overseas cost per ton x 0.40). Table 21 details these costs.

TABLE 21

Transportation Costs of TOE Equipment

Activity	Cost, dollars per ton		
	CONUS	CONUS to overseas	Worldwide average
SCA 2250.1 Land Transportation (CONUS)	35	35	—
SCA 2270.1 Operation of Ports and Terminals (CONUS)	—	16	—
SCA 2250.3 Sea Transportation	—	55	—
SCA 2270.1 Operation of Ports and Terminals (Overseas)	—	8	—
SCA 2250.1 Land Transportation (Overseas)	—	6	—
Total cost per ton	35	120	69

MAJOR OVERHAUL AND MAINTENANCE OF MATERIEL, BP 2300*

The aggregated depot maintenance data presented in the President's Budget submissions[2] do not provide the connective mechanism for relating depot maintenance activity rates and costs to a force change. As depot maintenance is a function of the materiel contained in the force, it is necessary to determine the force-change requirements for depot maintenance before any attempt at costing can be made. The materiel items of the force must be enumerated (specified) as a first step in computation of depot maintenance costs.

Three methods have been proposed for determining depot maintenance costs: (a) specifying every materiel item in the force change; (b) specifying only those materiel items from an enumerated group of high-cost and/or high-density materiel items, and applying an aggregate factor to the remaining unspecified items; (c) specifying the materiel items of the force change by their dollar value in commodity groups.

The first two methods require a large amount of detailed depot maintenance data since depot entry rate and overhaul cost data are necessary for each individual specified materiel item. Without computer assistance a large amount of time is required to perform these types of specification and costing; moreover it is not readily apparent that such detailed specification would produce cost estimates of significantly improved accuracy. For these reasons the third method, which is built on aggregate depot maintenance CERs that enable the analyst to quickly make hand-computations of costs, was selected for this analysis.

Development of Depot Maintenance Major Overhaul CERs

The materiel items included in the Army's inventory were classified into six simple but sufficiently detailed materiel categories to give reasonable estimations for developing CERs:

(a) Combat vehicles and equipment
(b) Tactical and support vehicles and equipment
(c) Electronic and communications equipment
(d) Missile ground equipment
(e) Fixed-wing aircraft
(f) Rotary-wing aircraft

These materiel categories conform to those set forth in the AMP,[15-19] with the exception of Fixed- and Rotary-wing aircraft, which is a split of the AMP aircraft designation. Army marine materiel (watercraft), railroad locomotives, and railroad rolling stock have been excluded from the tactical and support materiel category.

To develop factors, two sets of ratios were computed for each of the six materiel categories as shown in Table 22. The first set of ratios estimates the quantity of a given specified inventory of materiel that requires depot maintenance by determining the ratio between specified inventory dollar value and dollar value of the materiel to be overhauled. The second set of ratios

*In preparing this section the author has drawn heavily from a previously written RAC paper that deals exclusively with materiel maintenance.[7]

estimates the direct depot maintenance cost (repair-parts cost and direct operation and maintenance labor cost) generated from the quantity of materiel items to receive depot maintenance. These ratios were computed from the first ratio by determining the ratio between the dollar value of the materiel to be overhauled and the cost of depot maintenance of this materiel.

TABLE 22

Ratios Computed To Determine Depot Overhaul Cost Factor

Materiel categories	First ratio[a]	Second ratio[b]	Factor[c]
Combat	0.036	0.125	0.00446
Tactical and support	0.057	0.185	0.01056
Electronics and communication	0.082	0.131	0.01027
Missiles	0.090	0.114	0.01155
Aircraft			
Fixed wing	0.033	0.117	0.00382
Rotary wing	0.119	0.142	0.01686

[a]Ratio of dollar value of materiel overhauled to dollar value of materiel inventory.

[b]Ratio of total annual depot maintenance cost to dollar value of materiel overhauled.

[c]Depot overhaul cost for given inventory of materiel items (first ratio × second ratio).

Four steps are used to estimate depot maintenance costs employing these values:

(a) Determine the dollar value of all materiel by the previously mentioned materiel categories.

(b) Multiply the value of the total materiel in a category by the applicable materiel factor. The product of this multiplication is the direct cost of depot maintenance. (Repeat for each materiel category.)

(c) Multiply the total direct cost of depot maintenance by the residual depot maintenance cost factor to determine the residual depot maintenance costs.

(d) Sum the results of steps b and c for the total force cost of depot maintenance.

A numerical example is given for estimating depot maintenance costs with these values.

Given 100 combat vehicles whose standard cost is $200,000 each,

100 × $200,000 = $20,000,000 total value of materiel
$20,000,000 × 0.00446 = $89,200 direct cost of depot maintenance
$89,200 × 0.27 (residual depot maintenance cost factor) = $24,084
$89,200 + $24,084 = $113,284 total depot maintenance cost during the year for the given 100 combat vehicles

Depot maintenance is largely influenced by institutional characteristics. A time-series analysis of depot maintenance costs was discarded in favor of factors that reflect current depot maintenance experience. It should be pointed

out that final description has not been established by these factors, and they must be updated if they are to reflect the principle of current experience. However, if in several updatings a consistent pattern emerges, some generalization may be hypothesized.

Data for this analysis on quantities of materiel overhauled, reported cost of depot maintenance of this materiel, number of end items in the materiel inventory, and unit cost per item of the material were obtained from AMP.[17~19] No attempt was made to aggregate or subdivide the source data. Furthermore these must be recognized as secondary data, which could not be verified for completeness or accuracy.

These two ratios were determined in four steps:

(a) Individual materiel items were listed for each materiel category. The total number of each item in the Army inventory, unit cost of the item, number overhauled, and unit cost of depot maintenance for each item were tabulated.

(b) From the parameters listed the value of the materiel inventory for each individual materiel item was found by multiplying the total number of individual materiel items by the unit cost of the item and by summing the products of these multiplications for the total value of a materiel category. The value of the individual item overhauled was found by multiplying the number of items overhauled by the unit cost of the item and by summing the products of these multiplications for the total value of materiel overhauled in a category.

(c) The ratio for determining the value of materiel overhauled to total inventory value for a materiel category was found by dividing the total value of materiel overhauled by the total inventory value for each materiel item.

(d) The ratio for estimating the cost of depot maintenance was determined to be the ratio of total depot maintenance cost to the total value of materiel overhauled and was found for each materiel category by dividing the sum of depot overhaul for each individual item by the total value of materiel overhauled.

Symbolically the first and second ratios are given as equations:

$$\sum_{j=1}^{n_i} A_{ij}C_{ij} \Big/ \sum_{j=1}^{n_i} I_{ij}C_{ij} \quad V_i$$

$$\sum_{j=1}^{n_i} A_{ij}D_{ij} \Big/ \sum_{j=1}^{n_i} A_{ij}C_{ij} \quad R_i$$

the CERs then become

$$\sum_{j=1}^{n_i} A_{ij}D_{ij} \Big/ \sum_{j=1}^{n_i} I_{ij}C_{ij} \quad W_i$$

where i = materiel categories
j = individual items in a materiel category
A = number of end items overhauled for an individual materiel item
C = unit cost of an individual materiel item

D - unit cost of depot maintenance attributed to an individual materiel item
I - Army inventory for an individual materiel item
V - ratio of inventory dollar value to dollar value of inventory to be overhauled
R - ratio of dollar value of materiel to be overhauled to cost of depot maintenance of this materiel
W - total depot maintenance

Development of the Residual Depot Maintenance Cost Factor

The residual depot maintenance cost factor is designed to include those activities associated with materiel items that do not warrant special calculations by individual materiel item or materiel groupings because of their small magnitude of both quantity and cost. The factor includes those additional depot maintenance activities and their costs that will accrue with force changes and treats them as an add-on to the costs of major overhaul activity.

The factor was computed from the FY66 President's Budget submissions[2] by summing the dollars of Weapons (2310.1), Related Maintenance Activities (2350 less aircraft 2350.15) and Basic Issue List Item (2350.5) and dividing this dollar sum by the dollar sum of Major Overhaul Activities (2310 less weapons 2310.1). The calculation made with the FY66 data gives a residual depot maintenance cost factor of 0.27 ($31,686,000 ÷ $115,468,000). This factor is multiplied by the sum of the total depot maintenance cost found by the above CERs and added to that total. The data used for developing this factor are shown in Table 23.

Included in BP 2300 are those costs associated with General Support Maintenance of Army Aircraft (2350.15). As these 2350.15 costs are a segment of the total aircraft maintenance costs, they have been included in the aircraft support maintenance CERs developed in the previous section on BP 2000.

TABLE 23

Data Used To Develop Residual Depot Maintenance Cost Factor[2]

Activity	Cost, thous of dollars
Major overhaul activities	115,468
Combat vehicles	26,134
Tactical and support vehicles	10,042
Electronic and communication equipment	12,922
Aircraft	15,706
Missile systems	13,080
Other major equipment	7,584
Other force-unit-related depot maintenance activities	31,686
Weapons	6,401
Repairs and serviceability testing	11,578
Fabrication	957
Other related maintenance	8,845
Basic-issue list items	3,905

MEDICAL ACTIVITIES, BP 2400

Medical Activities is an integrated program of the total budget program corresponding to the single force-dependent cost category of Medical Activities. The portion of the budget structure that was determined to be force dependent was equated to a single force-dependent cost category and is a ready-made framework for cost analysis of OMA Medical Activities. The medical budget activities (Operations of Hospitals, Dispensaries, and Dental Service Units, BPA 2420; Medical Services in Non-Army Facilities, except Medicare Administered by Executive Agent, BPA 2430; Medicare Administered by Executive Agent, BPA 2440), provide for the actual care of the sick and injured and are expected to depend on changes in military strength resulting from force changes.

The cost of medical activities is a direct function of the number of personnel in a force change. Calculation of the medical activities cost factor consisted of summing the costs of the force-dependent activities and dividing the total cost by the total military strength (FY66 President's Budget submissions[2]) to form the annual recurring medical cost per man as follows:

$$\$137,444,000 \div 961,700 = \$143 \text{ (worldwide cost per military man)}$$

Implicit in the analysis is the assumption that the ratio of military dependents (wives, children, and other legal dependents) to military strength is approximately the same for any given total force structure.

Only a worldwide medical cost was calculated because the structure of the medical system is essentially one of joint costs owing to mobility of the sick and injured from the smaller to the larger medical facilities and from

TABLE 24

Data Used To Develop Medical Activities Cost Factor[2]

Account No.	Account name	Cost, thous of dollars		
		Total	Non-force-dependent costs	Force-dependent costs
BP 2400	Medical Activities	174,300	36,856	137,444
BPA 2409	Operation and Maintenance of Facilities	9,388	9,388	—
BPA 2410	Office of The Surgeon General	3,181	3,181	—
BPA 2420	Operation of Hospitals, Dispensaries and Dental Service Units	91,963	—	91,963
BPA 2430	Medical Services in Non-Army Facilities, except Medicare Administered by Executive Agent	23,747	564[a]	23,183
BPA 2440	Medicare Administered by the Executive Agency	22,774	476[b]	22,298
BPA 2450	Medical Training	6,142	6,142	—
BPA 2460	Other Medical Activities	17,105	17,105	—

[a]SCA 2430.9—Physical Examination of Reserve Personnel: Army Reserve (incl. ROTC), 100,000; National Guard, 464,000.

[b]BPA 2440—Office of Dependent Medical Care Costs.

overseas to CONUS hospitals. The meaningful allocations of these joint costs to individual medical facilities and activities are not possible because of lack of data. The two primary joint costs are the use of CONUS medical centers and general hospitals by overseas theaters and the impact of an overseas theater on the Medicare Program.

Table 24 lists the cost data from the FY66 President's Budget submissions.[2]

ARMY-WIDE ACTIVITIES, BP 2500

Army-Wide Activities provides funds for a large group of heterogeneous activities that are necessary to the overall operation of the Army. Since most of these activities are headquarters command, control, service, and information-gathering activities, the relation to the individual force change cannot be formulated directly. From the total activities contained in this budget program, four BPA's were determined to depend on force changes. These four are indirectly related to a force change by virtue of the services these activities perform. The four activities include (a) Major Field Command Headquarters, BPA 2520; (b) Recruiting and Other Personnel Support, BPA 2530; (c) Other Administrative Services, BPA 2540; and (d) Army-wide Finance and Audit Services, BPA 2580.

TABLE 25

Data Used To Develop Army-Wide Activities Cost Factor[2]

Account	Cost, thous of dollars	Force-dependent cost per military man
BP 2500 Army-Wide Activities		
Cost Dependent with force-unit changes	227,425	45
BPA 2520 Major Field Command Headquarters	71,732	14
BPA 2530 Recruiting and Other Personnel Support	22,055	4
BPA 2540 Other Administrative Services	84,909	17
BPA 2580 Army-Wide Finance and Audit Services	48,729	10

Since these four designated activities are of the overhead type, the direct relation to a force change cannot be empirically tested nor can a workload or performance factor be determined that will provide a basis for estimation. For these reasons the total dollar amounts represented by these four activities were employed as an independent variable, and it was assumed that the cost of these activities is entirely personnel dependent. Using total dollars as a variable, it was estimated that the force-dependent cost per military man is 2×10^{-7} of the total activity cost.

The results of the foregoing analysis, using the FY66 President's Budget submissions as the data source,[2] produce the force-dependent costs per military man shown in Table 25.

From BPA 2530 the cost of recruiting SCA 2530.1, in addition to being a part of the force-dependent annual operating cost, is also an OMA investment cost. Using the same data as were used for determining the average number of basic trainees[26] in BPA 2150 and the FY66 President's Budget submission[2] the investment cost per recruit is computed as $14,517,000 ÷ 228,487 = $64.

OPERATION AND MAINTENANCE OF FACILITIES, BP 9000

The following activities of OMF were determined to be force dependent: Local Headquarters Command Administration, BPA 9010; Local Maintenance and Management of Facilities (Active Facilities only), BPA 9030; Field Maintenance, BPA 9040; Post Supply, SCA 9050.1; The Army Food Program, SCs 9050.41 to 9050.45; Laundry and Drycleaning Services, SCA 9050.5.

OMF accounts are developed for the President's Budget submissions[2] separately from the mission accounts, BP 2000 to BP 2900. The applicable OMF activities and their cost designated to each of the mission OMA accounts are presented in the President's Budget submissions as the total BPA 2009, which is the aggregation of BPAs 9010 to 9060. Since the President's Budget does not give any detail for OMF, other data sources were required for the analysis of BPA 2009. The data used for the analysis were obtained from the COB[3] and are presented in Table 26. No distinction was made between SCA 2009.1 (OMF Operating Forces, less ARADCOM) and SCA 2009.2 (OMF ARADCOM) in order to correspond to the analysis of BP 2000.

The number of military men supported by BPA 2009 was obtained from "OMA Buildup Factor."[27]

Local Headquarters Command Administration, BPAs 2009, 9010

Local Headquarters Command Administration was estimated to change with force changes at a rate of one-quarter of the total cost per military man. From FY66 COB data[3] the total cost per military man for BPAs 2009, 9010 was $135 ($70,817,000 ÷ 4). The data by budget account are shown in App A.

Local Maintenance and Management of Facilities (Active Facilities Only), BPA 2009, SCA 9030.1

Local Maintenance and Management of Facilities is applicable to BPA 2009 for force changes only. The cost of this activity was estimated to be totally dependent on the total number of military men in the force change. From FY66 COB[3] data the force-dependent cost per military man was $342 ($221,078,000 ÷ 647,295). The data by budget account are shown in App A.

OMF Support Maintenance, BPAs 2009, 9040

The cost of OMF support maintenance repair parts and civilian labor comprise the force-dependent cost of this activity. Total support maintenance repair-parts cost was estimated from CERs developed in BP 2000. Since support maintenance repair parts have been accounted for, only the support maintenance civilian labor costs require estimation. To estimate the force-dependent

TABLE 26

Data Used to Develop Operation and Maintenance of Facilities Cost Factor[3]

Account No.	Account name	Cost, thous of dollars
BPAs 2009–9010	Local Headquarters and Command Administration	87,474
SCA 9010.1	Headquarters Operations	70,817
SCA 9010.2	Preservation of Order	8,108
SCA 9010.3	General Educational Development of Military Personnel	7,752
SCA 9010.4	BOQ and Civilian Dormitory Furniture	797
BPAs 2009–9030	Local Maintenance and Management of Facilities	
SCA 9030.1	(Active Facilities only)	221,078
SC 9030.12	Utilities	93,609
SC 9030.13	Fire Prevention	9,854
SC 9030.14	Maintenance and Repairs	94,540
SC 9030.15	Other Repairs and Utilities	12,019
SC 9030.16	Alterations and Minor Construction	11,056
BPAs 2009–9040	Support Maintenance	120,725
SCA 9040.1	Weapons	3,385
SCA 9040.2	Combat Vehicles	6,252
SCA 9040.3	Tactical and Support Vehicles	30,210
SCA 9040.4	Electronics and Communication Equipment	9,057
SCA 9040.5	Aircraft	8,199
SCA 9040.6	Missile Systems	30,852
SCA 9040.7	Special Purpose Equipment	32,770
BPAs 2009–9050	Local Logistic Services	
SCA 9050.4	The Army Food Program	8,272
SC 9050.41	Operation of Issue Commissaries	4,427
SC 9050.42	Operation of Garrison Bread Bakeries	325
SC 9050.43	Operation of Central Meat Processing Facilities	735
SC 9050.44	Operation of Messes	2,726
SC 9050.45	Operation of Central Pastry Kitchens	59
SCA 9050.5	Laundry and Dry Cleaning Services	8,270
SC 9050.51	Army Operated Laundries Facilities	7,154
SC 9050.52	Army Operated Dry Cleaning Facilities	512
SC 9050.53	Purchased Laundry and Dry Cleaning	604

support maintenance civilian labor it was necessary to isolate the total cost of civilian labor from repair parts and other costs. The only source of data was the object class data, expressed as funded cost, that are shown in Table 27. Two adjustments were then necessary to (a) determine personnel costs as a percentage of total BPA 9040 and (b) determine the BPAs 2009, 9040 Direct Obligations personnel costs. The personnel cost as a percentage of total BPA 9040 was found to be 0.57, and multiplying the total BPAs 2009, 9040 Direct Obligations personnel cost by this percentage gave $69 million ($120,725,000 $\hat{x}$ 0.57).

To relate support maintenance civilian labor to support maintenance repair-parts cost a coefficient was developed that expresses support maintenance civilian labor cost as a function of support maintenance repair-parts cost. From FY66 budget submissions[2] data, BP 2000 Support Maintenance was estimated at $322 million. Dividing $69 million support maintenance civilian labor cost by $322 million repair-parts cost gives a coefficient for support maintenance civilian labor of 0.214. The data used in these calculations are shown in Tables 27 and 28. The data by budget account are shown in App A.

TABLE 27

Data Used To Develop Support Maintenance Cost Factor[3]

Category	FY66 COB funded cost,[a] thous of dollars
BPA 9040 Field Maintenance	162,507
Total Personnel Costs	92,775
Personnel Compensation US	(72,188)
Personnel Benefits US	(5,632)
Personnel Compensation, Direct-Hire Foreign Nationals	(3,534)
Personnel Benefits, Direct-Hire Foreign Nationals	(78)
Indirect-Hire Foreign Nationals	(11,342)
Supplies and Materiel (Repair Parts)	48,481
Other Object Classes	21,251

[a]Numbers in parentheses are breakdowns.

TABLE 28

Analysis of BPA 9040 Support Maintenance

Category	Cost, percent, or ratio
Personnel costs as a percentage of total BPA 9040	57
Supplies and materiel cost as a percentage of total BPA 9040	30
BPA 9040, Direct obligation, personnel cost, millions of dollars	87
Total BPAs 2009–9040, thous of dollars	120,725
Total BPAs 2009–9040 as a percentage of total BPA 9040	79
Direct obligations BPAs 2009–9040 personnel costs, millions of dollars	69
Estimate of FY66 BP 2000 repair-parts cost, millions of dollars	322
Ratio of BP 2000 repair-parts cost to BPAs 2009–9040 personnel costs	0.214

Local Logistic Services, BPAs 2009, 9050

Three activities from BPA 9050 have been designated as dependent on force changes: The Army Food Program, SCs 9050.41 to 9050.45; Laundry and Drycleaning Services, SCA 9050.5; and Post Supply Operations, SC 9050.11.

From FY66 COB data[3] the force-dependent cost per military man for the Army food program was calculated as $13 ($8,272,000 ÷ 647,295).

The force-dependent cost per military man for laundry and drycleaning services was calculated from the same source [$13 ($8,270,000 ÷ 647,295)].

The data by budget account for the Army Food Program and Laundry and Drycleaning are shown in App A.

Cost of Post Supply Operations was computed from the total SC 9050.11 because the tonnages were not given by budget program. From FY66 COB[3]

data the force-dependent cost per ton was computed by dividing the total SC 9050.11 dollars by the total tons given in the President's Budget submissions[2] for Supply Depot Operation, BPA 2220. From FY66 COB[3] and the budget submissions, the force-dependent cost per ton was calculated as $62 ($61,792,000 ÷ 995,000 tons). The dollar cost for Post Supply Operations by budget program is given in the accompanying tabulation.

Code	Cost, dollars
Total	61,792,000
BP 2000	39,299,000
BP 2100	8,878,000
BP 2200	10,414,000
BP 2300	1,063,000
BP 2400	274,000
BP 2500	1,863,000

Appendix A

SUPPORTING DATA FOR DEVELOPMENT OF CERs

INTRODUCTION

Appendix A contains in Tables A1 to A13 the supporting backup data used in Chap. 3 for the development of OMA incremental force cost CERs.

Linear regression analysis was the analytical form employed for estimating the annual support maintenance cost for the 14 materiel items. The annual support maintenance cost was set as the dependent variable and the standard cost of the materiel items as the independent variable. From regression analysis the resulting estimation equation took the form:

$$\hat{Y} = b_0 + b_1 X$$

where $\hat{Y}$ = mean lifetime annual repair-parts maintenance cost for organizational and direct and general support maintenance

b_0 = the Y intercept

b_1 = the slope of the regression line

X = the standard cost of the materiel item (end item)

Calculation of the regression parameters yields

$b_0 = 0$

$b_1 = 0.046$

$r = 0.985$, coefficient of correlation

$r^2 = 0.970$, coefficient of determination

$S_{b_1} = 0.023$, standard error of b_1

Substituting the calculated parameters in the general regression equation yields

$$\hat{Y} = 0 + 0.046X \quad \text{or} \quad \hat{Y} = 0.046X$$

The finding $b_0 = 0$ has great advantages because the equation is not sensitive to different density ratios of materiel item types (end items). From the above equation the CER can be written

$$\hat{Y}_n = 0.046 \sum_{i=1}^{n} X_i$$

where $\hat{Y}_n$ = the total mean lifetime annual repair-parts cost of organizational and direct and general support maintenance for the total number of combat, tactical, and support end items to be costed

$\sum_{i=1}^{n} X_i$ = the sum of the standard cost of the total combat, tactical, and support end items to be costed

TABLE A1

Repair-Parts Data Used To Develop a Support Maintenance CER [8–12, 22].

Vehicle	Standard cost, dollars	Mean annual support maintenance repair-parts cost, dollars
Truck, ¼ ton, ABT	2,800	276
Truck, ¾ ton, ABT	4,300	253
Truck, 2-½ ton, ABT	8,400	373
Truck, 5 ton, ABT	12,300	564
Tank, combat, full-tracked, M48A2	159,000	6624
Carrier, personnel, full-tracked, M59	33,000	1944
Howitzer, light and medium, SP	122,000	6564
Tractor, full-tracked, LS, DD, heavy DBP	17,800	680
Tractor, full-tracked, LS, DD, medium DBP	25,000	632
Grader, 6 × 4, SP	11,800	501
Crane, 20 ton, truck-mounted	27,600	1054
Tractor, WHLD, gas, PT, 2000 lb DBP	2,000	112
Truck, fork lift, gas SRT, 4000 lb	3,400	150
Truck, fork lift, gas PT, 6000 lb	3,800	156

TABLE A2

FY63 (Actual) Repair-Parts Stock-Fund Data[13]

Stock Fund	FY1963 OMA Issues, dollars
Total	341.7
Engineer repair parts	18.6
Mobility repair parts	12.1
Signal repair parts	63.0
TC secondary items	5.7
Tank automotive repair parts	102.6
Weapons repair parts	23.8
Chemical repair parts	7.5
Missile repair parts	63.5
Aircraft repair parts	44.9

TABLE A3

Aircraft Data Employed To Develop Maintenance and POL Cost per Flying Hour CERs [20, 21, 24]

Aircraft	Basic weight, lb	Organizational direct and general support repair-parts cost per flying hour, dollars	Fuel, gal per flying hour
Rotary wing			
OH-13	1,786	10.77	12
OH-23	1,914	11.87	15
UH-1	4,800	49.18	50
UH-19	5,740	24.30	50
CH-21	8,899	32.25	68
CH-34	7,768	28.91	72
CH-37	21,500	99.87	200
CH-47	17,312	—	190
Fixed wing			
OV-1	10,000	67.88	200
CV-2	18,605	56.16	125
U-1A	4,900	8.23	30
U-8	5,000	14.66	34
O-1	1,618	4.02	8
U-6	3,100	9.49	22

TABLE A4

TOEs Sampled, POL per Hour and Estimated POL per POL Cost and Estimated Annual POL Cost [22, 23]

TOE	POL per hour, gal	Estimated POL per hour, gal
5-7D	102	93
5-17D	60	55
5-35E	381	361
5-37D	93	80
5-38D	84	90
5-77E	140	93
5-78E	257	249
6-125D	104	147
6-157E	34	44
6-215E	116	200
6-217D	20	38
6-315D	555	641
6-401D	173	216
6-415D (TOW)	280	298
6-415 (SP)	35	60
7-15E	134	232
7-17D	8	16
7-25D	624	586
7-42E	46	80
7-45E	336	376
9-75T	297	322
9-357D	67	74
11-5D	265	354
11-8D	91	124
11-37E	84	108
17-35D	1,064	1,077
17-51D	2,460	3,042
17-57D	106	162
19-37E	32	80
51-2D	34	38
55-17E	14	28
55-56D	219	134

TABLE A5

TOEs and Data Used To Develop OMA Unspecified Materiel Initial Investment CER [25]

TOE	OMA cost, dollars	Military men	Per capita OMA cost, dollars	Median per capita OMA cost, dollars
1-75E	107,503	318	338	200
3-36E	7,853	31	253	—
3-47E	18,838	99	193	—
3-117E	19,562	73	268	—
5-127E	33,309	202	165	—
6-165E	116,721	605	193	—
6-347E	19,167	93	206	—
7-15E	84,811	830	102	—
7-47E	16,181	199	81	—
8-35E	204,527	396	516	—
9-86E	15,889	72	220	—
10-7E	65,034	123	529	—
11-85E	73,823	815	91	—
12-37E	122,687	333	368	—
17-37E	14,350	90	159	—
17-105E	157,663	816	193	—
19-35E	68,751	654	105	—
29-75E	322,449	721	447	—
55-18E	31,343	182	172	—
55-89E	33,962	181	188	—

TABLE A6

Data BPA 2150 Replacement Training in US Army Training Centers [26]

End of fiscal year	Inductions	First enlistments	Total inductions and first enlistments	Total Army enlisted strength	Annual induction and enlistment rates
1957	179,432	68,752	248,184	886,807	0.2799
1958	126,495	78,269	204,764	787,738	0.2599
1959	111,170	113,098	224,268	760,274	0.2950
1960	90,266	102,114	192,380	771,842	0.2492
1961	60,216	116,129	176,345	758,701	0.2324
1962	157,517	127,063	284,580	950,354	0.2994
1963	74,387	111,746	186,133	867,614	0.2145
1964	150,688	116,202	266,890	862,368	0.3095

TABLE A7

TOEs Sampled To Compute Force-Unit Consumption Tonnage [22]

TOE	TOE materiel, thous of dollars	Military men	TOE	TOE materiel, thous of dollars	Military men
3-7D	555	246	10-107D	685	284
3-47D	120	99	10-377E	249	271
3-147E	305	131	11-5D	4,916	531
5-7D	1,172	166	11-8D	1,860	174
5-17D	300	106	11-15D	5,400	707
5-35D	1,743	619	11-25D	2,592	885
5-37F	391	154	11-37E	1,592	138
5-38D	421	178	11-85E	6,442	815
5-77E	650	127	11-95D	9,961	1,114
5-78E	2,294	225	11-155D	3,326	843
5-115D	2,126	893	11-555D	730	356
5-237D	887	195	11-587R	138	286
5-278E	577	199	12-27D	136	177
6-125D	2,026	317	17-15E	4,124	402
6-157E	360	105	17-25D	15,125	716
6-215E	1,642	450	17-32D	178	64
6-217E	225	100	17-35D	12,998	572
6-315D	3,915	575	17-51E	30,277	2,800
6-401E	253	106	17-57D	1,258	149
6-415E SD	3,155	578	19-35E	754	654
6-415E TOW	2,253	578	19-37E	154	196
7-15E	1,476	830	19-55E	917	688
7-17E	104	184	30-17E	197	61
7-25E	4,717	1,027	30-22D	367	118
7-42E	837	123	51-2D	2,801	144
7-45E	4,937	901	55-17E	731	168
8-77C	166	105	55-18E	1,239	182
8-127D	265	97	55-56E	932	72
9-7D	599	181	55-89E	581	139
9-9D	649	201	55-117D	606	329
9-17D	479	92	55-458D	865	223
9-47D	1,183	246	55-469D	1,146	271
9-75D	1,741	574	44-545D	6,274	549
9-197D	543	185			
9-357D	361	293	Total	171,402	27,682
10-7E	256	150			
10-105D	1,421	599			

TABLE A8

TOE Materiel Value and Materiel Tons Used To Develop a Materiel-Tonnage-Estimating Relation [22]

TOE	TOE materiel, thous of dollars	Value actual tons	Predicted materiel tons
3-7D	555	510	526
3-47D	120	137	380
3-147E	305	321	442
5-17D	300	300	439
5-35D	1,743	1,612	921
5-37F	391	301	471
5-77E	650	619	658
5-78E	2,294	1,223	1,109
5-115D	2,126	1,436	1,052
5-237D	887	607	637
5-278E	577	381	533
6-401E	253	140	424
8-127	265	157	429
9-7D	599	540	541
9-9D	649	535	558
9-17D	479	129	501
9-47D	1,183	1,287	737
9-197D	543	541	522
10-105D	1,421	1,004	816
10-107D	685	488	599
10-145D	1,942	1,288	991
11-15D	5,400	2,106	2,150
11-85E	6,442	2,224	2,499
11-95D	9,961	2,339	3,679
11-587R	138	257	386
17-25D	15,125	4,875	5,109
17-51E	30,277	10,972	10,488
19-35E	754	373	592
19-37E	151	111	392
19-55E	917	313	647
30-17E	197	65	406
55-17E	731	700	585
55-18E	1,239	1,070	755
55-56T	932	66	652
55-117D	606	102	513
55-458D	865	662	630

TABLE A9

Replacement Training in US Army Training Centers, Data FY64–FY66 [2, 28, 29]

Category	Actual FY64	Budget		
		FY64	FY65	FY66
BPA 2150, Replacement Training in US Army Training Centers, dollars	22,722,609	24,808,000	25,202,000	23,472,000
Less ROTC basic camp	—	—	—	88,000
Less Special Training and Enlistment Program	—	—	—	2,636,000
Total force-dependent costs, dollars	22,722,609	24,808,000	25,202,000	20,748,000
Total Active Army basic trainees	266,890	219,393[a]	209,860[a]	228,487[a]
Cost per trainee, dollars	85	113	120	91
Training rate	0.310	0.271[a]	0.251[a]	0.266[a]
Cost per incremental military man, dollars	26	31	30	

[a]Previous 4-year average.

TABLE A10

Local Headquarters and Command Administration [3]

Category	Account no.	BPA 2009–9010, dollars	Total BPA 9010, dollars
Local Headquarters and Command Administration		87,474,000	219,182,000
Headquarters Operations	SCA 9010.1	70,817,000	183,053,000
Preservation of Order	SCA 9010.2	8,108,000	23,279,000
General Educational Development of Military Personnel	SCA 9010.3	7,752,000	12,053,000
BOQ and Civilian Dormitory Furniture	SCA 9010.4	797,000	797,000
Military men		647,295[a]	961,700[a]
Force-dependent cost per military man		34	57

[a]Men, not dollars

TABLE A11

Local Maintenance and Management of Facilities[1]

(Active facilities only)

Category	Account no.	BPA 2009-9030, dollars	Total BPA 9030, dollars
Local maintenance and management of facilities (active facilities only)		221,078,000	331,608,000
Utilities	SC 9030.12	93,609,000	128,412,000
Fire Prevention	SC 9030.13	9,851,000	18,432,000
Maintenance and Repairs	SC 9030.14	93,540,000	150,041,000
Other Repairs and Utilities	SC 9030.15	12,019,000	21,523,000
Alterations and Minor Construction	SC 9030.16	11,056,000	16,200,000
Military men		647,295[a]	961,700[a]
Force-dependent cost per military man		342	348

[a]Men, not dollars.

TABLE A12

Support Maintenance (BPA 9040)[1]

Account name	Account no.	SCA 2009.1, dollars	SCA 2009.2 dollars	BPA 2009-9040, dollars	BPA 9040 (Total), dollars
		FY66			
Weapons	SCA 9040.1	3,087,000	298,000	3,385,000	5,031,000
Combat Vehicles	SCA 9040.2	6,052,000	200,000	6,252,000	8,368,000
Tactical and Support Vehicles	SCA 9040.3	27,901,000	2,309,000	30,210,000	38,314,000
Electronics and Communications Equipment	SCA 9040.4	7,130,000	1,927,000	9,057,000	13,018,000
Aircraft	SCA 9040.5	8,009,000	190,000	8,199,000	11,443,000
Missile Systems	SCA 9040.6	9,730,000	21,122,000	30,852,000	31,247,000
Special-Purpose Equipment	SCA 9040.7	28,642,000	4,128,000	32,770,000	45,588,000
Total	Total	90,551,000	30,174,000	120,725,000	153,009,000
		FY64			
Weapons	SCA 9040.1	3,331,000	180,000	3,511,000	5,326,000
Combat Vehicles	SCA 9040.2	6,546,000	200,000	6,746,000	9,808,000
Tactical and Support Vehicle	SCA 9040.3	30,950,000	1,979,000	32,929,000	42,676,000
Electronics and Communications Equipment	SCA 9040.4	7,077,000	1,902,000	8,979,000	13,228,000
Aircraft	SCA 9040.5	6,434,000	129,000	6,563,000	13,961,000
Missile System	SCA 9040.6	9,976,000	24,302,000	34,278,000	37,480,000
Special-Purpose Equipment	SCA 9040.7	28,179,000	4,421,000	32,600,000	46,372,000
		92,493,000	33,113,000	125,606,000	168,851,000

TABLE A13

The Army Food Program and Laundry and Drycleaning Services[a]

Account	Account no.	SC 2009–9050.xx, dollars	SC 9050.xx, dollars
The Army Food Program		8,272,000	13,831,000
Operation of Issue Commissaries	SC 9050.41	1,427,000	7,520,000
Operation of Garrison Bread Bakeries	SC 9050.42	325,000	512,000
Operation of Central Meat Processing Facilities	SC 9050.43	735,000	1,015,000
Operation of Messes	SC 9050.44	2,726,000	4,608,000
Operation of Central Pastry Kitchens	SC 9050.45	59,000	176,000
Military men		647,295[a]	961,700[a]
Force-dependent cost per military man		13	14
Laundry and Drycleaning Services		8,240,000	12,133,000
Army Operated Laundry Facilities	SC 9050.51	7,154,000	10,293,000
Army Operated Drycleaning Facilities	SC 9050.52	512,000	749,000
Contractual Laundry and Drycleaning Services	SC 9050.53	604,000	1,091,000
Military men		647,295[a]	961,000[a]
Force-dependent cost per military man, dollars		13	13

[a]Men, not dollars.

Appendix B

REFERENCE DATA, BY BUDGET PROGRAM

INTRODUCTION

Appendix B contains historical budget cost and work-measurement data, by Budget Program. These data were used as reference and background for both the structural analysis and the development of CERs. They are provided in this appendix as a body of data for the reader's reference and for preservation for future work in OMA analysis.

TABLE B1

Total Cost and Workloads, Cost per Workload Unit for BP 2200 Activities for FY64–FY66[28,29,30]

Activity	Actual cost in FY64, dollars[a]	Budget cost, dollars		
		FY64	FY65	FY66
Supply Depot Operations				
SCA 2220.1 CONUS				
Receiving	7,405,000	6,786,000	11,399,000	7,086,000
Shipping	18,176,000	18,589,000	24,096,000	16,122,000
Storage	7,945,000	10,258,000	10,623,000	7,611,000
Receiving, Stons	1,046,000	1,164,000	1,719,000	995,000
Shipping, Stons	1,236,000	1,441,000	1,672,000	1,097,000
Storage, Stons	5,571,000	6,618,000	7,239,000	5,270,000
Receiving, cost per Ston	7.08	5.83	6.63	7.12
Shipping, cost per Ston	14.71	12.90	14.43	14.97
Storage, cost per Ston	1.43	1.55	1.47	1.45
Total cost per Ston	23.22	20.28	22.51	23.54
SCA 2220.1 Overseas				
Receiving	3,448,000	3,540,000	3,599,000	3,197,000
Shipping	4,742,000	3,986,000	4,220,000	4,368,000
Storage	3,714,000	5,495,000	3,338,000	2,290,000
Receiving, Stons	1,024,000	1,060,000	1,056,000	946,000
Shipping, Stons	1,120,000	1,030,000	1,047,000	1,028,000
Storage, Stons	1,423,000	1,621,000	1,589,000	1,258,000
Receiving, cost per Ston	3.08	3.34	3.41	3.38
Shipping, cost per Ston	4.23	3.87	4.03	4.25
Storage, cost per Ston	2.61	3.39	2.10	1.82
Total, cost per Ston	9.92	10.60	9.54	9.45
Land Transportation				
SCA 2250.1 CONUS				
Amount, tons	845,000	1,027,000	1,143,000	823,000
Total cost	29,318,219	41,474,000	38,061,000	29,037,000
Cost per ton	34.70	40.38	33.29	35.28
SCA 2250.1 Overseas				
Amount, tons	4,107,000	4,398,000	4,613,000	4,248,000
Total cost	24,762,235	26,305,000	23,496,000	25,795,000
Cost per ton	6.03	5.98	5.07	6.07

TABLE B1 (continued)

Activity	Actual cost in FY64, dollars[a]	Budget cost, dollars		
		FY64	FY65	FY66
SCA 2250.1 Worldwide				
Amount, tons	4,952,000	5,425,000	5,776,000	5,071,000
Total cost	54,080,454	67,779,000	61,557,000	54,832,000
Cost per ton	10.92	12.49	10.66	10.81
Sea Transportation				
SCA 2250.3 Army dry cargo				
Amount, measuring tons	5,317,761	4,791,000	5,212,100	5,219,600
Total cost	114,863,627	95,242,000	108,307,000	114,885,000
Amount, Stons	2,127,104	1,916,400	2,084,840	2,087,840
Cost per Ston	54.00	49.70	51.94	55.02
Operation of ports and terminals				
SCA 2270.1 CONUS				
Amount, measuring tons	4,794,180	4,196,100	4,461,500	4,880,000
Total cost	31,977,333	29,005,000	31,004,000	31,292,000
Amount, Stons	1,917,672	1,678,440	1,784,600	1,952,000
Cost per Ston	16.68	17.28	17.37	16.03
SCA 2270.1 Overseas				
Amount, measuring tons	7,574,800	6,788,700	6,841,400	7,245,600
Total cost	25,208,249	22,163,000	23,945,000	24,683,000
Amount, Stons	3,029,920	2,715,480	2,736,560	2,898,240
Cost per Ston	8.32	8.16	8.75	8.52

[a]Except as noted in stub column.

TABLE B2

Cost of Supply Depot Operations for FY64–FY66[28, 29, 30]

Activity	Actual FY64	Budget		
		FY64	FY65	FY66
Supply Operations				
SCA 2220.1 CONUS, cost per Ston, dollars	46.16	40.95	45.01	44.97
Receiving	13.91	11.83	13.41	13.62
Shipping	29.42	25.99	28.68	28.58
Other storage	2.83	3.13	2.92	2.77
Other related activities (fraction)	0.51	0.52	0.83	0.57
Receiving	0.11	0.10	0.21	0.13
Shipping	0.28	0.27	0.43	0.30
Other storage	0.12	0.15	0.19	0.14
SCA 2220.1 Overseas, cost per Ston, dollars	20.25	21.23	19.22	17.38
Receiving	6.76	6.74	6.84	6.25
Shipping	8.31	7.76	8.14	7.77
Other storage	5.18	6.73	4.24	3.36
Other related activities (fraction)	0.64	0.65	0.50	0.64
Receiving	0.19	0.18	0.16	0.21
Shipping	0.25	0.20	0.19	0.28
Other storage	0.20	0.27	0.15	0.15

TABLE B3

Major Overhaul and Maintenance of Materiel, Historical Data for FY64–FY66[28, 29, 30]

Activity	Actual cost in FY64, dollars	Budget cost, dollars		
		FY64	FY65	FY66
BPA 2310, Major Overhaul Activities	94,913,102	107,726,000	120,469,000	121,869,000
Weapons	1,564,429	3,219,000	1,779,000	6,401,000
Combat vehicles	28,565,053	28,383,000	32,900,000	26,134,000
Tactical and support vehicles	5,230,020	9,351,000	8,960,000	10,042,000
Electronic and communications equipment	9,830,320	16,157,000	11,379,000	12,922,000
Aircraft	38,536,566	37,409,000	46,600,000	45,706,000
Missile systems	6,167,181	6,123,000	10,006,000	13,080,000
Other major equipment	5,020,543	7,084,000	8,845,000	7,584,000
BPA 2350, Related Maintenance Activities	30,725,806	38,341,000	32,537,000	31,146,000
Repairs and serviceability testing	8,291,442	16,041,000	10,706,000	11,578,000
Fabrication	1,313,659	2,700,000	1,103,000	957,000
Aircraft heavy maintenance	11,143,250	13,800,000	12,118,000	9,766,000
Other related maintenance	9,977,455	5,800,000	8,610,000	8,845,000
SCA 2350.5, Basic Issue List Items	5,773,990	4,810,000	4,338,000	3,905,000

TABLE B4

Other Variable Depot Maintenance Cost Factors for FY64–FY66 Computed from Budget Data

Activity or cost factor	Actual cost in FY64, dollars	Budget cost, dollars		
		FY64	FY65	FY66
Major overhaul activities (less weapons)	93,348,673	104,507,000	118,690,000	115,468,000
Other force-unit depot maintenance costs	26,920,975	32,570,000	26,536,000	31,686,000
Weapons	1,564,429	3,219,000	1,779,000	6,401,000
Related maintenance activities (less aircraft)	19,582,556	24,541,000	20,419,000	21,380,000
Basic issue list items	5,773,990	4,810,000	4,338,000	3,905,000
Other variable depot maintenance cost factors	0.2884	0.3116	0.2236	0.2744

TABLE B5

Medical Costs per Military Man for Actual FY62–FY64; Budget FY64–FY66[2, 28–30]

Year	Cost, dollars	Active army strength	Medical cost per military man, dollars
Actual			
FY62	134,300,903	1,015,061	132
FY63	127,720,622	975,916	131
FY64	132,118,831	960,100	137
Budget			
FY64	134,201,000	965,854	139
FY65	137,442,000	972,311	141
FY66	137,444,000	961,700	143

TABLE B6

Medical Costs for Active Army plus Dependents for Actual FY62–FY64 and Budget FY64–FY66[28–30]

Year	Cost, dollars	Total active army strength plus dependents	Medical cost per person, dollars
Actual			
FY62	134,300,903	2,360,061	57
FY63	127,720,622	2,280,916	56
FY64	132,118,831	2,272,100	58
Budget			
FY64	134,201,000	2,258,854	59
FY65	137,442,000	2,288,311	60
FY66	137,444,000	2,273,700	60

TABLE B7

Medical Costs per Military Man by BPAs for Budget FY64–FY66[28–30]

Account	Budget cost		
	FY64	FY65	FY66
BP2400			
Cost per military man, dollars	139.00	141.00	143.00
BPA 2420			
Cost per medical action, dollars	2.60	2.82	2.67
Cost per military man, dollars	94.00	94.00	96.00
BPA 2430			
Cost per medical action, dollars	24.00	26.00	28.00
Cost per military man, dollars	22	24.00	24.00
BPA 2440			
Cost per military man, dollars	23.00	23.00	23.00
Hospital rate per 100 strength	0.35[a]	0.35[a]	0.34[a]
Cost per patient day, dollars	53.75	55.90	57.63

[a]Ratio.

TABLE B8

Budget Data and Medical Actions for FY64–FY66[28–30]

Account	Fiscal year	Annual total medical actions	Cost, thous of dollars	Cost per medical action, dollars	Medical actions per military man	Medical actions per person
BPA 2420						
	FY64	34,801,842	90,482,000	2.60	—	—
	FY65	32,575,520	91,713,000	2.82	—	—
	FY66	34,395,775	91,963,000	2.67	—	—
BPA 2430						
	FY64	900,360	21,371,000	23.74	—	—
	FY65	892,425	23,184,000	25.98	—	—
	FY66	820,520	23,183,000	28.25	—	—
BPA 2440						
	FY64	1,637,118	22,348,000	13.65	—	—
	FY65	1,677,540	22,545,000	13.44	—	—
	FY66	1,627,900	22,298,000	13.70	—	—
Total BP 2400						
	FY64	37,339,230	134,201,000	3.59	38.7	16.5
	FY65	35,145,485	137,442,000	3.91	36.1	15.4
	FY66	36,844,195	137,444,000	3.73	38.3	16.2

TABLE B9

Army-Wide Activities (BP 2500)—Historical Data FY64–FY66[28–30]

AMS Code Activity	Actual cost in FY64, dollars	Budget cost, dollars		
		FY64	FY65	FY66
Variable cost activities, total cost				
BPA 2520, Major Field Command Headquarters	77,262,285	74,061,000	68,547,000	71,732,000
BPA 2530, Recruiting and Other Personnel Support	21,128,901	21,174,000	20,691,000	22,055,000
BPA 2540, Other Administrative Services	71,691,576	68,744,000	70,439,000	84,909,000
BPA 2580, Army-Wide Finance and Audit Services	44,436,775	45,442,000	46,939,000	48,729,000
Variable cost activities, total cost per military man	222	217	211	236
BPA 2520, Major Field Command Headquarters	80	77	70	74
BPA 2530, Recruiting and Other Personnel Support	22	22	21	23
BPA 2540, Other Administrative Servicer	74	71	72	88
BPA 2580, Army-Wide Finance and Audit Services	46	47	48	51
Variable cost activities, cost per military man (total cost multiplied by 2×10^{-7})	42	42	41	45
BPA 2520, Major Field Command Headquarters		15	14	14
BPA 2530, Recruiting and Other Personnel Support		4	4	4
BPA 2540, Other Administrative Services	1	14	14	17
BPA 2580, Army-Wide Finance and Audit Services	9	9	9	10

REFERENCES

CITED REFERENCES

1. Dept of Army, "The Army Management Structure (Fiscal Code)," AR 37-100, Jun 64.
2. ——, Office of the Comptroller, "Justification of Estimates for FY66 OMA," Tabs 1-9, submitted to Congress, Jan 65.
3. ——, Comptroller of the Army, "TAABS—The Automated Army Budget System," Command Operating Budget—FY66, All Commands and Agencies, Summarized, OMA Book Number 99, 18 Apr 65.
4. John J. Surmeier, "An Individual System/Organization Cost Model: Vol I, Concept and Application," RAC-TP-183, Research Analysis Corporation, Nov 65.
5. Jodie T. Allen, "An Individual System/Organization Cost Model: Vol II, Computer Program Design and Operation," RAC-TP-183, Research Analysis Corporation, Jan 66.
6. Dept of Army, "Program Element/Army Management Structure Correlation Tables," 1 Oct 64.
7. John G. Phillips, "O&M Materiel-Maintenance Calculations for the Army Force Structure Cost Model," RAC-TP-164, Research Analysis Corporation, Mar 65.
8. Operations Research Office (now RAC), "Operation, Maintenance, and Cost Experience of ¼-ton Truck Fleet (U)," ORO-T-382, May 61. CONFIDENTIAL
9. ——, "Economics of Maintenance and Replacement of ¾-, 2½-, and 5-ton Truck Fleets (U)," ORO-T-401, Sep 61. CONFIDENTIAL
10. ——, "Operation, Maintenance, and Cost Experience of the Tank, Armored Personnel Carrier, and Self-Propelled Howitzer Vehicle Fleets (U)," RAC-T-409, Sep 62. SECRET
11. Operations Research Office (now RAC), "Maintenance and Operating Costs for Air-Ground Vehicles," Vol II, Tab C, of RAC's contribution to the Howze Board Report, retained in RAC as unpublished data, Jul 62. CONFIDENTIAL
12. ——, "Operation and Maintenance Experience of the Heavy and Medium Tractors (Crawler), and 20-ton Crane, Road Grader, 1.5- kw Generator, and 45-kw 400-cps Generator," RAC-T-428, Aug 63. FOR OFFICIAL USE ONLY
13. Dept of Defense, Office of the Assistant Secretary of Defense (Comptroller), "Stock Fund by Materiel Category, FY63," prepared in 1964 for RAC Study 661.
14. Dept of Army, US Army Materiel Command, "Financial Inventory Accounting Summaries of Distribution of Army Inventories—Ending Fiscal Year 1963," Nov 63.
15. ——, Headquarters, "The Army Materiel Plan (U), FY62-FY69": Vol VII, "Weapons and Combat Vehicles," CSGLD 1138, Aug 63. SECRET
16. ——, "The Army Materiel Plan (U), FY62-FY69": Vol IV, "Tactical Vehicles and Other Equipment," CSGLD 1138, Aug 63. CONFIDENTIAL
17. ——, "The Army Materiel Plan (U), FY62-FY69": Vol II, "Communications and Air Defense," CSGLD 1138, Aug 63. CONFIDENTIAL
18. ——, "The Army Materiel Plan (U), FY62-FY69": Vol III "Missile Systems," CSGLD 1138, Aug 63. SECRET
19. ——, "The Army Materiel Plan (U), FY63-FY70": Vol I, "Aircraft and Related Items," CSGLD 1138, Jun 64. CONFIDENTIAL

20. ——, Aviation and Surface Materiel Command, "Maintenance and Operating Costs of Army Aircraft," Pam 335-3, Aug 63
21. ——, Office of the Chief of Staff, Office of the Director of Army Programs, "Five-Year Force Structure and Financial Program, FY64-FY69": Materiel Annex, Pt II, "PEMA Equipment Data Sheets," Army portion of the Weapons Dictionary, Jan 65. SECRET—RESTRICTED DATA
22. ——, Deputy Chief of Staff for Logistics, Data Processing Center, Radford, Va., "TOE, Costout of, on File, SRC's," Vols I and II, 30 Jan 64.
23. ——, Headquarters, "Staff Officers' Field Manual: "Organization Technical, and Logistical Data, Part I—Unclassified Data," FM 101-10, Oct 61.
24. F. W. Myers, "Aviation Cost Data," Research Analysis Corporation, unpublished data, M-4213, 14 Jul 64.
25. A. D. Stament, "TOE Equipment Cost Estimating Relations—A Preliminary Investigation," Research Analysis Corporation, draft technical paper, 9 Mar 65.
26. Dept of Defense, Office of the Assistant Secretary of Defense (Comptroller), Directorate for Statistical Services, "Selected Manpower Statistics," 19 Feb 65.
27. Dept of Army, Office of the Comptroller, "OMA Buildup Factor," 9 Jun 65.
28. ——, "Justification of Estimates for FY65," Vols 2 and 3, Tabs 5-15, submitted to Congress Jan 64.
29. ——, "Justification of Estimates for FY64," Vols 2 and 3, Tabs 5-15, submitted to Congress Jan 63.
30. ——, "Justification of Estimates for FY63," Vols 2 and 3, Tabs 5-14, submitted to Congress Jan 62.

ADDITIONAL REFERENCES

Dean, Joel, Managerial Economics, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1951.
Dept of Army, Office of The Surgeon General, "AMEDS Funding Handbook," Mar 63.
Hitch, Charles J., and Roland N. McKean, The Economics of Defense in the Nuclear Age, Harvard University Press, Cambridge, Mass., 1960.
Johnson, J., Statistical Cost Analysis, McGraw-Hill Book Company, New York, 1960.
Novick, David (ed), Program Budgeting, . . Program Analysis and the Federal Budget, Harvard University Press, Cambridge, Mass., 1965.
Quade, E. S. (ed), Analysis for Military Decisions, Rand McNally and Company, Chicago, Ill., 1964.
Research Analysis Corporation, "OMA Budget Development and Element Distribution: , Methods and Sources (U)," RAC-T-424, Apr 64. SECRET
——, "Guide for Reviewers of Studies Containing Cost-Effectiveness Analysis," Oct 65.

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13 ABSTRACT

The research reported in this paper develops a methodology for determining the cost impact of the operation and maintenance, Army (OMA) appropriation for the analysis of proposed force changes. The methodology is built around the Army's financial accounting system and relies primarily on Army budget data. Each account is classified to a level of activity detail that can be matched with quantities, either physical or measured in dollars, and for which there are descriptions of what specific OMA costs the account includes. Classification of OMA activities as to type of force dependency enables the computation of coefficients that relate specific activity costs to physical measures. A complete set of OMA cost-estimating relations (CERs) except for costs of training military occupational specialties illustrates how CERs can be developed from the Army's financial accounting system.

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